Exhibit 5-6

GENERIC WASTEWATER TECHNOLOGIES FLOW CHART

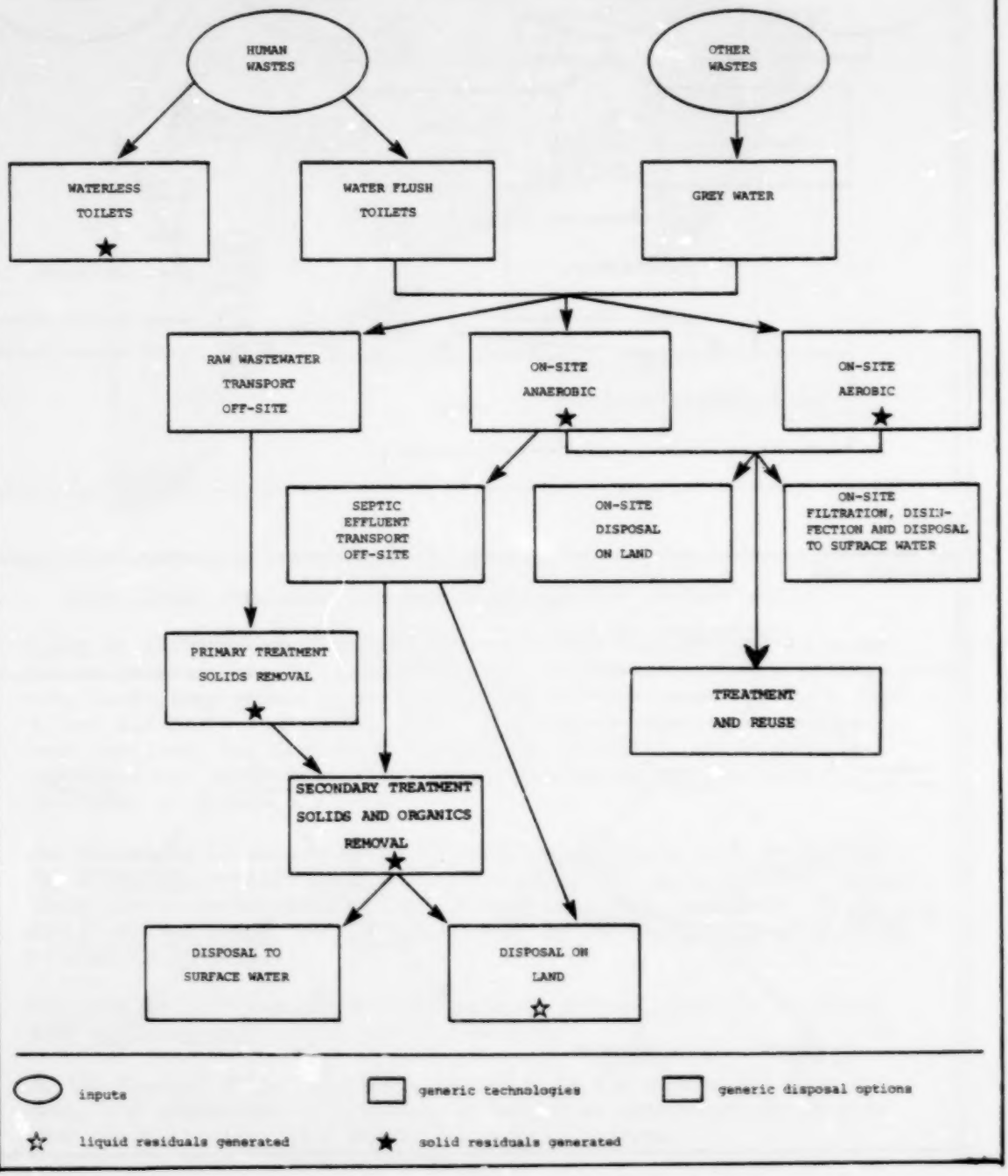


Exhibit 5-7

GENERIC TECHNOLOGIES FLOW CHART
SOLID RESIDUALS

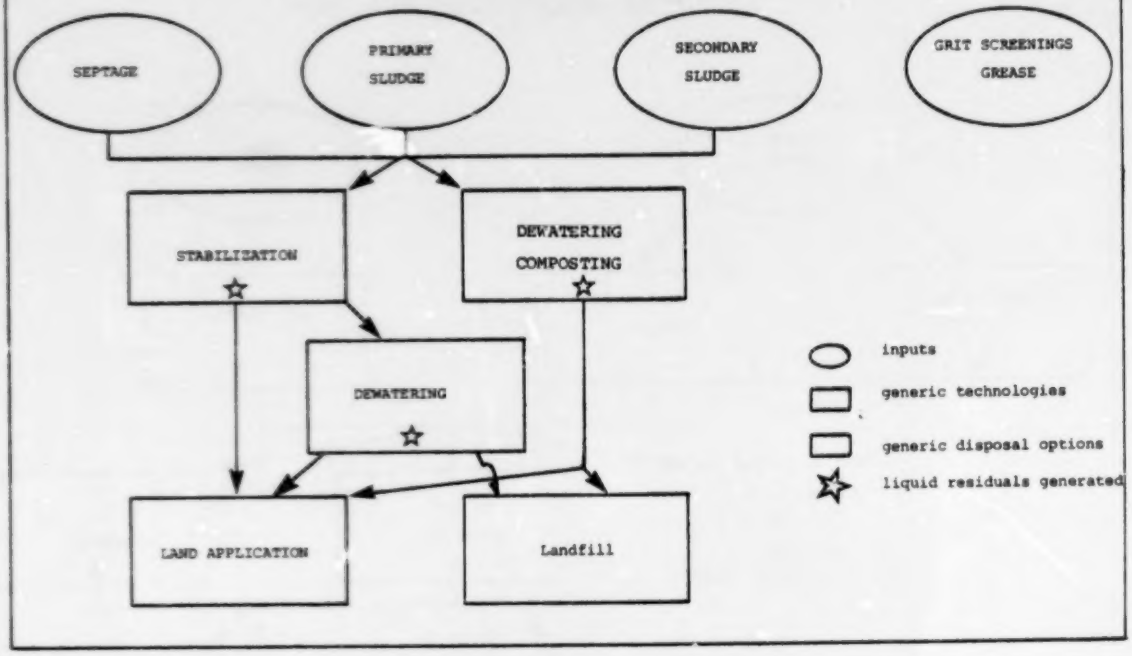


Exhibit 5-8

DECISION TREE
PRELIMINARY TECHNOLOGY EVALUATION FOR EACH PROBLEM

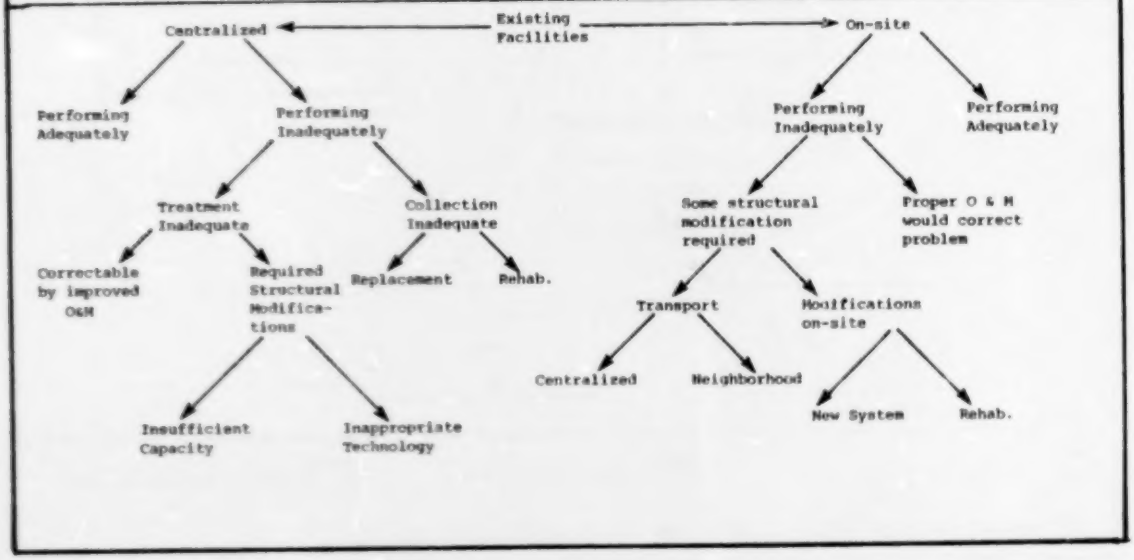
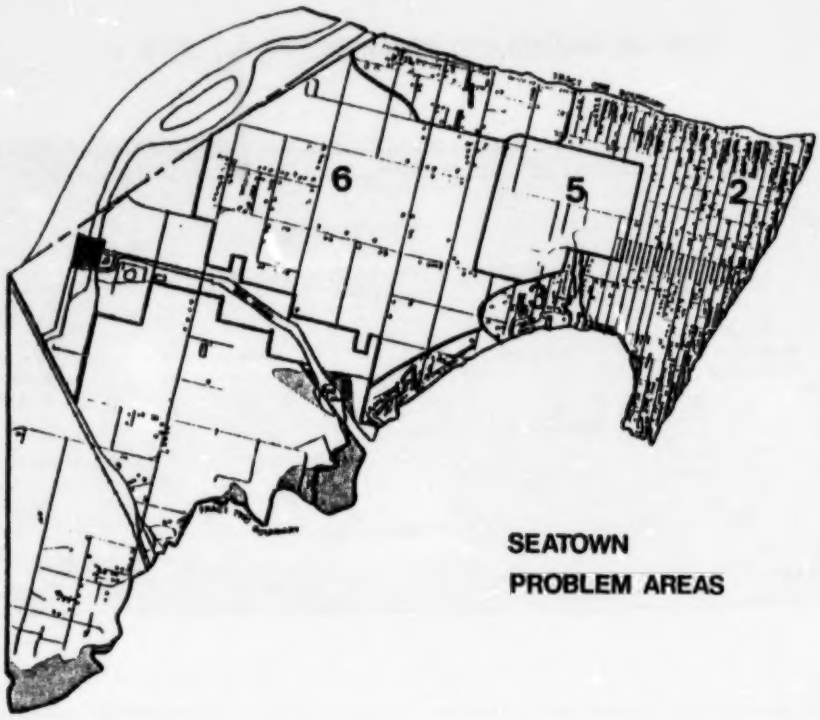


Exhibit 5-9



PRELIMINARY TECHNICAL EVALUATION FOR SEATOWN PROBLEM AREAS

Based on their common characteristics, the six Seatown problem areas can be grouped into two categories for the purposes of the preliminary technology evaluation. The coastal problem areas (1, 2, 3, and 4) are all densely populated and suffer current wastewater management problems; the Central problem areas (5 and 6) are largely unpopulated but could anticipate wastewater management problems if developed to higher densities.

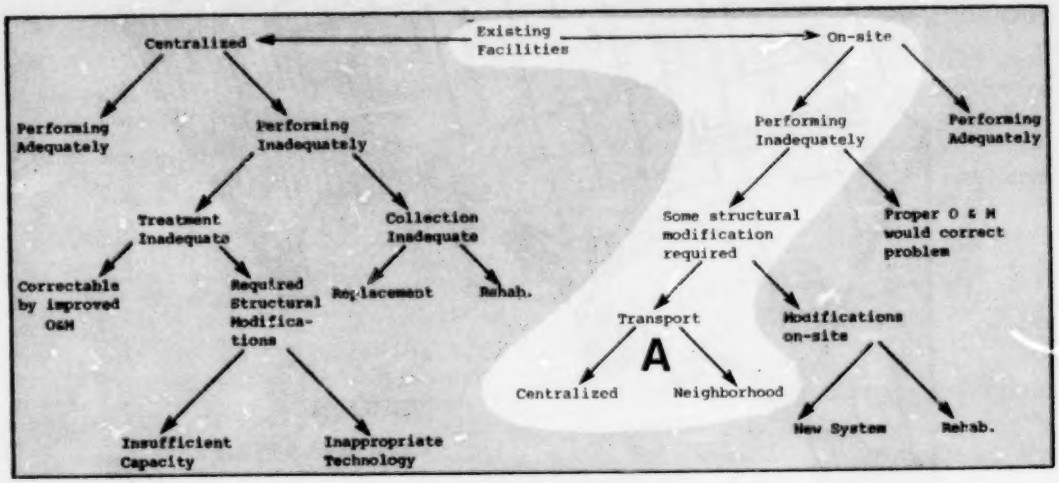
The following is a summary of the Preliminary Technology Evaluation for these two problem area categories using the decision tree. Since there are no centralized collection and treatment facilities in these problem areas, the left hand side of the decision tree is eliminated in both cases.

The problem in the Coastal areas is well defined, and little field work is necessary to evaluate alternatives.

In the Central areas, the major question is the demand for development, and additional information is needed to determine the density that could be adequately served by on-site systems.

Exhibit 5-9, p. 2

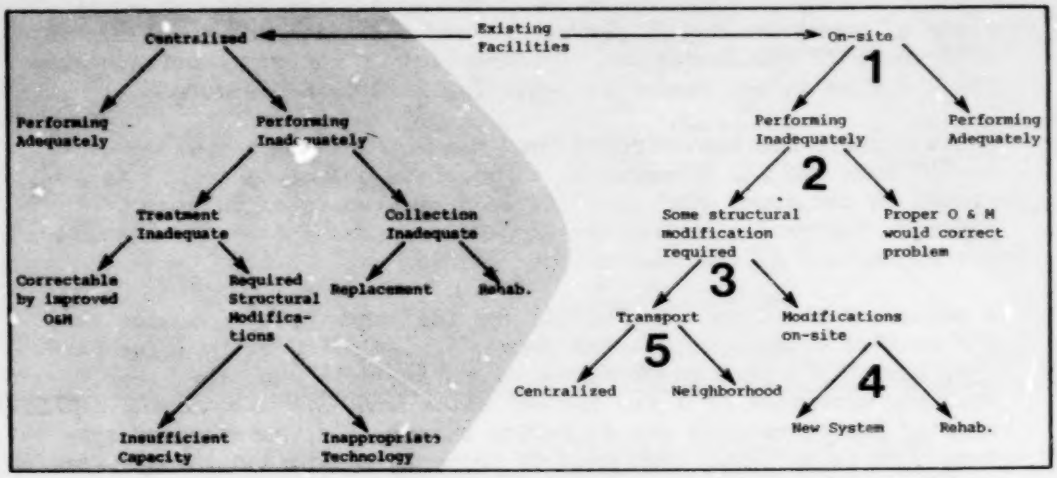
SEATOWN COASTAL PROBLEM AREAS (1, 2, 3, & 4)



DECISION POINT	*DATA DESIRED*
A	*Determine optimal scale for collection system* *-identify potential disposal sites* *-obtain accurate land use data* *-receive input from community*
TECHNOLOGIES ELIMINATED	*REASON*
Existing on-site Systems	*-water quality analysis indicates contamination with septic tank effluent* *-all parties interviewed confirmed system failures* *-large number of illegal direct connections to drainage ditches* *-poor permeability, high water table, heavy rainfall*
Modified On-site Systems	*-most existing units are on very small lots* *-continued high density development is desired*

Exhibit 5-9, p. 3

SEATOWN CENTRAL PROBLEM AREAS (5 & 6)



DECISION POINT	*DATA DESIRED*
1 and 2	*More specific information on performance needed* *-conduct house to house survey in area* *-interview septic haulers*
3	*Determine types, frequency and location of failures and feasibility of rehabilitation* *-house to house survey* *-plat maps* *-soil tests*
4	*Determine the number of current and projected rehabilitations and replacements* *-analyze age of systems and sanitary codes in effect at various times* *-carefully review Board of Health enforcement records for the area* *-interview septage haulers*
5	*Determine optimal scale for collection system* *-identify potential disposal sites* *-obtain accurate land use data* *-receive input from community*

Exhibit 5-10

PRELIMINARY TECHNOLOGY EVALUATION FOR A MID-WESTERN COMMUNITY

This example is based on a hypothetical midwestern farm community where there have been a significant number of on-site failures, both in the small town and on the farmsteads. The community consists of approximately 50 farmsteads and a small cross-roads center with about 15 residences and 10 commercial or municipal buildings. The lot size in the center is generally less than 1/4 acre.

The community has been divided into two problem areas: the center of town and the farmsteads. A moderate amount of growth is expected in the town, with very little growth expected in the outskirts. The preliminary technology evaluations for the problem areas are summarized by the diagrams and charts.

A review of the Community Profile for the farmsteads indicates that the on-site systems, which were generally installed 30 to 50 years ago, have had a poor performance record over the past ten years. With the exception of a few systems which have been completely replaced, most of the farmsteads are depending on very old, substandard systems. It is unlikely that even if properly maintained the systems could provide adequate service over a twenty year planning period.

Because of the long distances between farms, the engineer focussed on on-site treatment and disposal. The number of systems to be replaced or rehabilitated could not be determined from the information available.

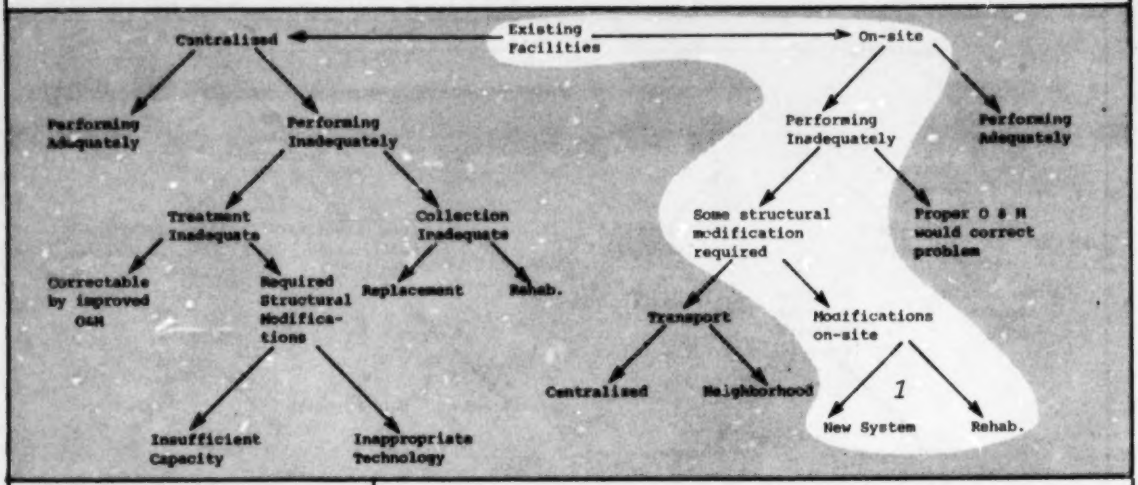
However the analysis of soils data indicated two general conditions so two typical leach fields could be designed. An estimate of how many of each type of system would be used was made from the soils maps. Since most existing systems could not be expected to perform adequately for the next twenty years, the engineers decided for costing purposes to assume that new septic tanks and leach fields would be installed at each farmstead.

For the purpose of the facilities planning process, therefore, it was determined that field work to evaluate every system was not warranted. The assumption of complete replacement is, of course, extremely conservative and would have to be justified by supporting data on system age and performance. Therefore, the engineer decided to carefully examine the Board of Health files and interview the local septage haulers. If the result of this field work indicated the assumption to be inaccurate, then some revision would be required.

The preliminary evaluation of the technical options for the center of town revealed that the lots are too small to permit extensive

Exhibit 5-10, p. 2

DECISION TREE
FARMSTEAD PROBLEM AREA



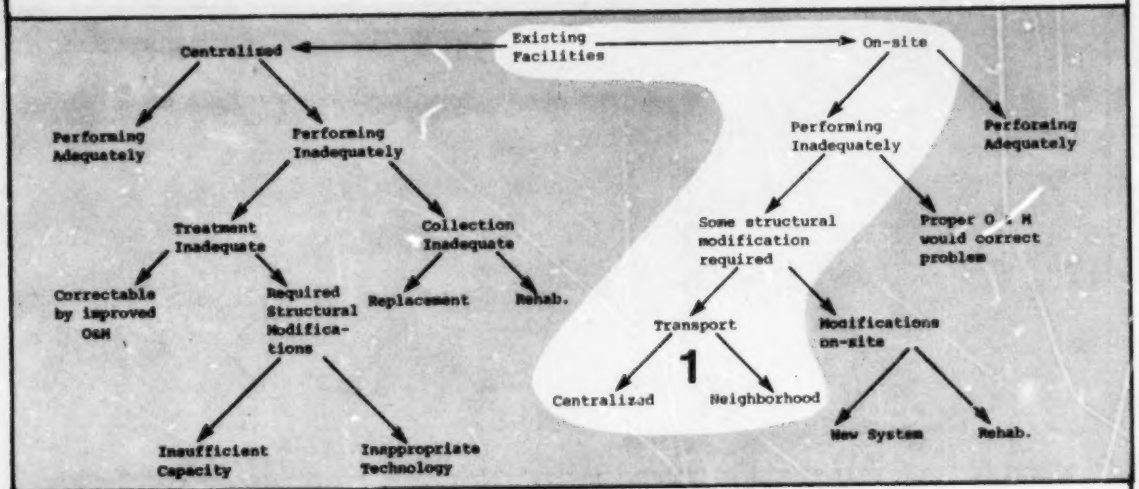
DECISION POINT	*ADDITIONAL INFORMATION NEEDED*
1	*Confirm assumption that most systems are very old, and few would be adequate for the 20 year planning period.*
OPTIONS ELIMINATED	*REASON*
Continued use of Existing Systems	*-Consensus of regulators, Board of Health*
O&M of Existing On-site	*-Failures are too serious and frequent, and systems are old, substandard and over loaded*
Transport of Effluent	*-Distances between units is too large*

replacement or rehabilitation of on-site disposal systems. This fact combined with land availability makes the use of community leach fields the preferred option if continued use of septic tanks is anticipated. It was therefore determined that additional information on the performance of individual leach field was not required and that a conservative approach calling for new septic tanks would be taken for cost estimating purposes.

Thus the focus of additional data collection should be on the suitability of possible community leach field sites. Soil testing and

Exhibit 5-10, p. 3

DECISION TREE
CENTER OF TOWN PROBLEM AREA



DECISION POINT	*REASON*
1	*It is not clear whether one or more neighborhood systems would be most cost-effective. Adequacy and location of disposal sites requires more research.*

OPTIONS ELIMINATED	*REASON*
Continued use of Existing On-Site	*-Results of county sampling program, consensus of regulators*
O&M of Existing On-site	*-Failures are too serious and frequent, and Systems are old, substandard and over loaded*
Modification of On-Site	*-Lots are too small*

investigations into the availability of the proposed sites would be very useful. The results of this evaluation should be used in sizing the leach field, or fields, and determining the optimal sewer technology.

5.3 FIELD WORK DESIGN AND DATA COLLECTION

Once the preliminary technology evaluation for each problem area has been completed, the engineer should have a good idea of what information will be needed to narrow the range of options and to develop the plans necessary for cost-effectiveness analysis. Additional information will inevitably be needed to complete a cost-effectiveness analysis of integrated programs to serve the entire community. Therefore, Field Work to generate the specific information required consists of original data collection, interviewing and retrieval of additional secondary source data.

While every facilities planning area presents a unique set of problems for data collection, there are some guidelines which are useful to remember. A Field Work plan should be developed to make the most of limited resources. On the basis of the preliminary evaluation, the engineer should determine what information is really needed. A list of potential sources and an organized plan of data collection should be developed to reduce the number of repeat visits and overall costs.

The possibility of retaining expert opinions should be examined at this point since the engineer can clearly define what tasks such consultants could complete. While preliminary budgets for expert consultants must be submitted with the planning grant application, the actual scopes of work to be done by consultants should only be developed at the point where the project engineer knows what information would be most useful. Because it is not always possible to predict the level of uncertainty, modifications to the planning budget may be required.

The engineer should evaluate the performance of existing centralized facilities using both secondary sources and original data collection. If current treatment plants are not meeting their discharge permit requirements, it is important to find out why. For example, if the problem is only the management of a well-designed and correctly-sized system, this can be corrected with training, technical assistance, and other operations support, without any requirement for large scale upgrading or modification. On the other hand, if the problem is poor design, some modification of the capital equipment may be required. If the problem is simply insufficient treatment capability or hydraulic overload, then upgrading and expansion may be necessary.

The engineer should work with the operators of any existing plants and obtain information on the variation in wasteloads over time, effluent quality, operating procedures and so forth. Any unusual operating problems should be noted, so that they can be considered in the generation of alternatives and the selection of systems.

Exhibit 5-11 uses the Hilltown case study to illustrate the field work conducted to evaluate the performance of existing on-site systems. The techniques illustrated in this example combined with the analyses of the same area during Problem Area Identification (Exhibit 5-4) provide some good ideas for data collection and analysis on this difficult question.

Exhibit 5-11

HILLTOWN - ON-SITE SYSTEMS

Based on the Preliminary Technology Evaluation of the problem areas in Hilltown currently dependent on on-site systems, it was determined that the continued use of such systems might be desirable. However additional information on current system performance and expected performance of future systems was needed before a final decision could be made. In addition the Board wanted to confirm allegations that septic tank effluents were contaminating the stream and threatening the water supply.

The town's engineer initiated a surface water sampling program which was carried out during the peak population months of June and July. The results of the program confirmed the conclusions reached by the State. Further, the results indicated definite presence of synthetic detergents in the streams. This supported the assumption that the contaminants are man-generated and not the result of intermittent animal defecation in the surface waters.

Records for septage disposed at the local landfill revealed that a large number of truck loads had been dumped. However, without additional information it was difficult to convert the figure for number of truck loads dumped at the landfill to a number of septic tanks pumped, or to determine whether the pumping was simply a maintenance procedure or the result of septic system failure. To make these judgments the engineers interviewed the major septage haulers. These interviews revealed that virtually all pumpings were a result of malfunctions in the systems such as backed-up building sewers, blocked leach lines or septic tank, surfacing effluent, or malodorous condition.

On the basis of this information, the data on truckloads transferred to the landfill was used to estimate that 9 to 10% of the existing systems suffer failures each year. The haulers indicated that one of the problems was tree root intrusion, which is more serious in systems serving seasonal dewellings. Some seasonal residents have all but given up on clogged leach fields and used their septic tanks as holding tanks; several systems are pumped more than once per year.

Several technologies for the detection of septic tank failures are currently being tested. Among these are remote sensing by aerial photography* which detects areas where there is surface breakout of septic tank effluent and septic detection along shorelines** which detects leaching of effluents into surface water bodies. If there is a question as to whether existing systems are performing adequately or it is important to locate which specific systems are failing, the engineer may wish to investigate the use of such a technology. However, such advanced methods should only be employed in situations where the continued use of existing on-site systems is seriously contemplated. Frequently this level of detail would be more appropriate in the Step II Design.

Interviewing with both agencies and users can provide important original data on the performance of on-site systems. The Management Agency Profile presented in Exhibit 4-10 outlines the types of information about an agency the interviewer should request. It may be valuable to survey some of the residents and commercial users, particularly in areas where performance problems are not well defined and continued use of on-site systems is contemplated. Experience with mail surveys has indicated that the random nature of responses makes the results very difficult to use in actual facilities planning, though potentially useful in gaining a sense of the community preferences. Therefore, it is recommended that surveys be used in areas where door-to-door personal interviewing is logistically feasible. Even with the use of volunteer organizations as interviewers, a community-wide survey would only be recommended in very small communities. An example Residential Survey Form is presented in Exhibit 5-12.

Additional information about existing water quality or potential water quality impacts of various technical options may also be desired. Many engineering firms have sufficient in-house expertise to design a surface water sampling program and to analyze the results. Surface water analysis can be used, as in the Hilltown example, to confirm contamination by septic tank effluent. However, firms frequently do not have this type of expertise in groundwater analysis, where the number of variables is even greater. When it is necessary to assess the groundwater water quality impacts of land application systems, the engineer should first determine if groundwater is a serious issue. Clearly, water table aquifers which are used for drinking water supply present the most critical groundwater resource to be protected. It is similarly important to protect aquifers which feed surface water bodies which are sensitive to nutrient contamination. Groundwater quality and flow analysis including well sampling, development of flow nets and dye testing may be warranted. Particular concern should be placed on areas where homes have both private wells and septic tanks, areas around public wells and areas near sensitive surface water bodies.

As stated above, each community will possess a unique set of circumstances for field work design. Therefore, the engineer must carefully develop a field work plan before initiating original data collection. By planning the field work in advance, it should be possible to maximize the returns from data collection.

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*Environmental Photographic Interpretation Center.
**"Septic Leachate Detection - A Technical Break Through for Shoreline Lake System Performance Evaluation", W.B. Kerfoot

Exhibit 5-12 REQUEST FOR INFORMATION ON WASTEWATER DISPOSAL

The information on this form will be strictly confidential. Specific information from this form will be released for public review.

ADDRESS: _____

1. WHAT TYPE OF WASTEWATER DISPOSAL SYSTEM DO YOU HAVE? ____ septic tank/leaching field ____ cesspool

   ____ discharge to surface water ____ other ____ (location of discharge: _____

   _____)

2. WHEN WAS THE SYSTEM INSTALLED? _____

3. HAVE YOU HAD ANY PROBLEMS WITH YOUR WASTEWATER DISPOSAL SYSTEM? ____ yes ____ no

4. PLEASE TELL ME THE TYPES OF PROBLEM THAT BEST DESCRIBE OR DESCRIBED YOUR SITUATION. (CHECK MORE THAN ONE IF NECESSARY.)

   ____ slow drainage in sink and other water using appliance ____ odors outside

   ____ toilet sometimes backs-up ____ liquid is visible on the ground surface ____ Other _____

   _____

5. HOW OFTEN DO YOU HAVE PROBLEMS WITH YOUR SYSTEM?

   ____ weekly ____ monthly ____ frequently ____ other _____

6. IN WHAT SEASONS DO YOU GENERALLY HAVE PROBLEMS? (CHECK MORE THAN ONE IF APPROPRIATE.)

   ____ spring ____ summer ____ fall ____ winter

7. DO YOU HAVE PROBLEMS AFTER PERIODS OF FREQUENT OR HEAVY RAINFALL? ____ yes ____ no

8. HOW HAVE YOU COPED WITH THE PROBLEMS?

   a. ____ pumping
      - HOW OFTEN? ____ weekly ____ monthly ____ winter
      - WHAT IS THE COST OF PUMPING? _____

   b. ____ restricting water use
      - HOW? _____

   c. ____ repairing system
      - PLEASE DESCRIBE _____

   d. ____ other

   _____

(IF NO REPAIRS, SKIP TO QUESTION 10.)

9. IF YOU HAD YOUR SYSTEM REPAIRED, CAN YOU PLEASE TELL ME

   - WHEN WAS IT DONE? _____ • HOW MUCH DID IT COST? _____
   - WHAT WAS DONE? _____

     _____
   - WHO DID IT? _____
   - HAVE YOU HAD MORE THAN ONE MAJOR REPAIR DONE ON YOUR SYSTEM? ____ Yes ____ No

   IF YES, DESCRIBE _____

   _____

10. HOW OFTEN DO YOU HAVE YOUR SYSTEM PUMPED?

    ____ once a year ____ once every two years ____ once every three years ____ never

11. HOW MUCH DOES IT COST TO HAVE YOUR SYSTEM PUMPED? _____

12. WHAT WATER USING APPLIANCES DO YOU HAVE? ____ dishwasher ____ garbage disposal

    ____ washing machine connected to the disposal system ____ washing machine not connected to the disposal system

Exhibit 5-12, p. 2

REQUEST FOR INFORMATION ON WASTEWATER DISPOSAL

13. *WHEN WAS YOUR HOUSE BUILT?* _____

14. *WHAT IS THE APPROXIMATE SIZE OF YOUR HOUSE LOT?* _____

15. *HOW MANY PEOPLE LIVE IN YOUR HOUSEHOLD? ages:* ____ *0-12* ____ *12-18* ____ *18 & over*

16. *WHEN IS YOUR HOUSE OCCUPIED?* ____ *year round* ____ *seasonally* ____ *month occupied*

17. *DO ANY OF YOUR NEIGHBORS ON YOUR STREET HAVE PROBLEMS WITH WASTEWATER DISPOSAL?* ____ *yes* ____ *no*

- *WHY DOES IT APPEAR THERE IS A PROBLEM?*

  ____ *liquid is visible on the ground surface* ____ *odor* ____ *frequent pumping*

  ____ *other (explain)* _____

  _____

18. *DO YOU FERTILIZE YOUR LAWN ANNUALLY?* ____ *Yes* ____ *No*

- *APPROXIMATELY HOW MANY POUNDS OF FERTILIZER DO YOU APPLY?* _____

19. *DO YOU HAVE ANY COMMENT YOU WOULD LIKE TO MAKE?* _____

_____

THANK YOU FOR YOUR TIME. THERE WILL BE PUBLIC MEETINGS ON WASTEWATER PLANNING ANNOUNCTED IN _____

_____. *I HOPE YOU HAVE THE OPPORTUNITY TO ATTEND.*

5.4 TECHNOLOGY EVALUATION BY PROBLEM AREA

This is an iterative step where the engineer takes the information developed during the Field Work and applies it to the task of further narrowing the range of technical options for the individual problem areas. The objective is to reduce the number of options to make the development of community wide concepts an easier task. Thus, where the results of Field Work indicate that certain options are not feasible, the range can be narrowed. Where field work has provided additional information but that information is not sufficient for selecting among alternatives, the data can be used in performing more detailed cost-effectiveness analysis which would then be indicated.

5.5 ACCEPTABLE GENERIC OPTIONS BY PROBLEM AREA

This step involves public review of the Technology Evaluation. It is important that public acceptability of various technical alternatives be assessed before detailed cost-effectiveness analysis is completed. It makes little sense to prove that a technology would be most cost-effective if the community will not accept it. This step reflects the importance of an active public participation effort at this point in the planning process.

It is likely that a public meeting will not generate sufficient interest in the community to insure that all questions are raised. The engineer should be

prepared to spend the time necessary to generate as much interest in the planning process as possible. Press releases should be prepared regularly for the local paper so that the various options under consideration are introduced before any public meeting rather than reported after the fact. In larger communities a citizens advisory committee may be used. The members of this group can help disseminate information about the planning process. It may be possible to enlist the services of non-profit community organizations such as the Scouts or a high school civics classto help distribute leaflets and generate interest in the planning process.

In any case, it is unlikely that the community will be unanimously in favor of any single proposal. There will always be divergent points of view, particularly on controversial issues such as the provision of services to only a portion of the community or the impacts on growth. In preparing documents for presentation to the public, the engineer should be careful to address the questions most likely to be raised by the residential user:

- What will it cost?
- Will this mean more development in my neighborhood?
- How much development?
- Will I be subsidizing the people in the center of town (or vice versa)?

Clearly, some of these questions are appropriate early in the problem area identification step while others would be more appropriately addressed in the analysis of overall programs for the entire community. However, it is likely that they will all be raised at this point and the engineer should be prepared to either answer the questions or explain why they cannot be answered as yet.

CHAPTER 6

GENERATION AND EVALUATION OF SYSTEMS FOR THE COMMUNITY AS A WHOLE

The previous two chapters have presented methods for identifying wastewater management problems and devising ways to solve local problems using new facilities or non-structural controls. The goal of this stage of the planning is to integrate those solutions for the individual problem areas into community-wide systems which will effectively abate the pollution problem. Moreover, this stage must evaluate these proposed community-wide systems, so that the best can be chosen for implementation.

This is a difficult problem, and it is worthwhile to consider for a moment how difficult it might be. In Milltown, for example, there were 10 problem areas. Three to five generic technologies were developed for each problem area. By choosing combinations of these technologies for the problem areas, it would be easy to generate perhaps 40 community-wide systems for evaluation (and the number of possibilities is much larger). These possibilities would not even include such details as the type of transport system or treatment plant to be used, or whether land disposal should be surface or subsurface. Consideration of collection, treatment, and disposal technologies would at least triple the total, so that it would conceivably be necessary to prepare and evaluate detailed plans for 100 or more different systems.

Obviously, this is impossible. More important, most of these combinations would be unreasonable and could never be implemented. Therefore, a procedure is needed which will reduce these hundreds of options to a few, with detailed cost-effective and environmental evaluations performed only on those few. The screening of options done at each point must be consistent with the information available about them. Rough estimates should be used in the initial screening, with more detailed information developed when needed. Public participation will be important throughout.

Several evaluation criteria have to be considered, including:

- overall cost-effectiveness;
- local costs for all parts of the system;
- distribution of local costs (who pays and who benefits);
- dependability and risk;
- public acceptability;
- direct environmental impacts;

- operability;
- land use and development impacts, with consideration for what these potential changes would mean to the community and the environment;
- other socio-economic impacts.

There are five major decisions which must be made, and the remainder of this chapter is organized around those five decision points. They are:

- initial decision on system structure and discharge points for all wastes (6.2);
- a decision on the boundaries for all sewer service areas, and on the placement of projected growth (6.3);
- a decision on the technologies to be used for each area (6.4);
- decisions on management procedures, cost allocation, and staging (6.5);
- selection of the final recommended plan (6.6).

Exhibit 6-1 shows the organization in a flow chart. In addition, Section 6.1 describes a number of the critical issues which arise in evaluating projects, and which must be considered.

6.1 EVALUATION ISSUES

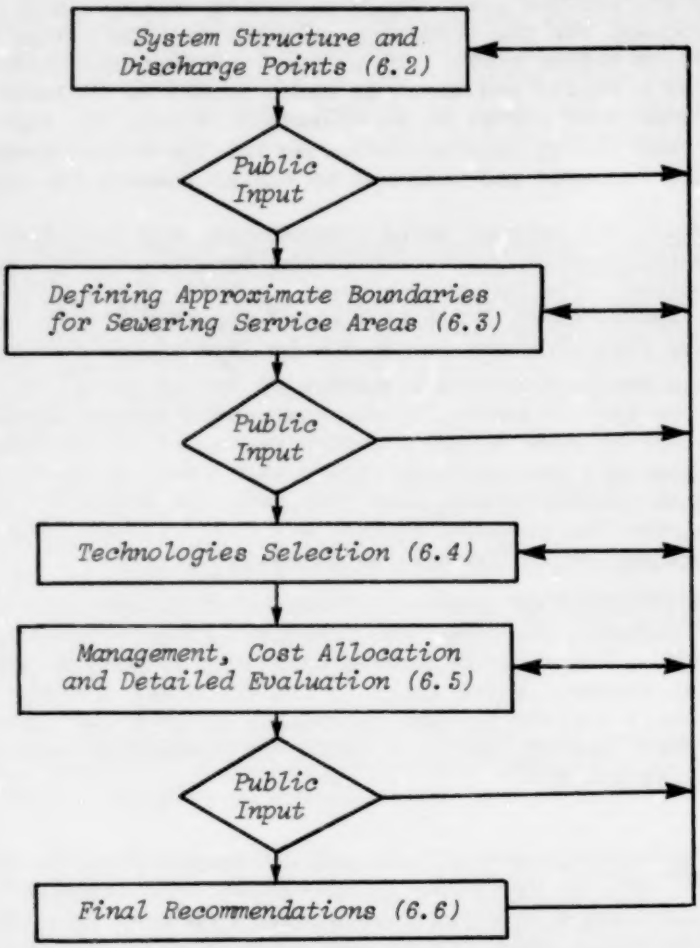
The basic question is "which mix of options for the community should be implemented?" Under each of the proposals, all wastewater must be handled in an acceptable and environmentally sound manner. Therefore, according to EPA regulations, each must be evaluated for its cost-effectiveness, as well as its other impacts--primarily environmental and socio-economic--on the community, with a goal of selecting the best community-wide system option. To do this, it is necessary to know how to evaluate the various options. The major factors were listed in the introduction to the chapter, but care is required if each is to be considered correctly.

It is a basic assumption that all the proposed systems must provice acceptable service to the residents and firms of the community, even though the method varies. In other words, the wastewater must be handled in an "environmentally sound manner" and one that is acceptable to the community. Any systems which do not meet such requirements should not be considered further. Public participation is important to assess acceptance of various technologies.

The residents must pay both the public and private costs of the system. For a fair evaluation, then, we must be concerned with the full costs of the system to all users. Cost-effectiveness from the national viewpoint is the key measure for receiving EPA grants, but local costs are also important. Care must be taken to avoid analyzing incomplete systems, where the costs are not comparable across technologies.

Exhibit 6-1

GENERATION AND EVALUATION OF COMMUNITY SYSTEMS


System Structure and Discharge Points (6.2)
Public Input
Defining Approximate Boundaries for Sewering Service Areas (6.3)
Public Input
Technologies Selection (6.4)
Management, Cost Allocation and Detailed Evaluation (6.5)
Public Input
Final Recommendations (6.6)

For example, one of the easiest ways to bias an analysis against on-site alternatives is to consider the full on-site system in the costing, but to start counting sewer costs at the street. The house connection can be extremely expensive in some cases, and should be considered as part of the wastewater management system.

Another way of analyzing incomplete systems is to analyze one system (i.e., a sewer) for its service area, while analyzing another (e.g., a septic tank maintenance program) for the community as a whole. The latter may serve more sites, and thus incur higher costs. It is our view that management is required for the community as a whole, and that all costs should be included in comparative analysis, even such things as an individual's cost for septic tank pumping. By requiring that all systems be evaluated for the entire area, the costs can be consistently compared and will not be biased towards the more limited options.

Design Lives: The salvage value evaluations, and the other portions of the cost analysis, require that design lives be estimated for the various technological options. For on-site systems, however, these design lives are difficult to estimate, since there is limited experience with them in-place. It is assumed here that 20 years is the design life of new on-site systems.

Therefore, a septic tank--soil absorption system installed under the plan would be assumed to last 20 years for the cost-effectiveness analysis. Similarly, in an area served with existing septic tanks, if 2% currently required major rehabilitation and new leaching fields each year, it is assumed that 2% would require rehabilitation each year over the design period. Detailed cohort analyses for existing systems may also be done, if past changes in in standards may have affected design life.

Certain technologies or components have known design lives which are relatively short, for example, the pumps for pressure sewers. It is assumed, though, that the piping for pressure sewers will last as long as the pipes for conventional sewers. Where there is limited other information, then, the engineer should attempt to make reasonable assumptions about design lives and point out these assumptions in a table for comment by reviewers in the community, State agencies and EPA.

Time-staging: Delaying (and discounting) future investments can reduce the cost of systems. This is desirable in many cases; for example, in Milltown, there was a trailer park with subsurface disposal on very small lots. In the problem area identification phase it became apparent that it would probably be only a matter of time before failures became common in this area, and systems would need to be installed, so the community systems include suggestions for this area.

However, no action is required now, and it may not be necessary to do anything for 10 years or so. Therefore, this phase of the overall project is suggested for later implementation.

Phasing of projects is suggested for study in the EPA Cost-Effectiveness Analysis Guidelines. However, it can bring about some problems in evaluation, particularly when different systems are staged differently. Assume, for example, that the options are to build a collection system and treatment plant, or to set-up

an on-site management district. Also assume (for the moment) that the on-site district is slightly cheaper. By phasing the collection system, and assuming that the areas to be served would require nothing while they awaited sewer construction, it might be possible to make the sewer system appear less expensive.

This is just another example of incomplete analysis. Actually, the areas which were planned to receive sewers in 10 or 15 years would need some sort of management system in the interim, and ignoring the costs of such a system would simply bias the analysis in favor of sewers. The complete systems to be compared should not only provide service to all households in the community, but provide such service for the full 20-year planning period. Staging plans can save a great deal of money, but they do not make problems go away, and the costs of meeting those problems while waiting for the staged investment should be considered.

Conflicts Between Cost-Effectiveness and Community Preferences: Standard procedure has been to provide grant assistance only for the most cost-effective alternative, except in very special cases. With the implementation of the Clean Water Act, this procedure has been modified in two ways: in many cases, the community can build excess capacity it desires without losing its Federal grant; and, Alternative and Innovative technologies can be selected if they are no more than 15% more costly than conventional systems.

However, if a community prefers to fund a land application system (qualifying as Alternative) that is 20%, or even 16%, more expensive than a traditional system, it will not be able to receive a grant for the project. It would have to either build the project selected by EPA, or fund the land application system locally, perhaps with some State assistance. There is no mechanism under the regulations for the EPA to give a grant of less than 75% for projects which are not the most cost-effective even if the community is willing to pay the difference.

This sort of conflict is likely to occur in small communities, particularly when Alternative and Innovative technologies are being evaluated; it is likely to lead to some problems in applying the regulations.

Distribution of Costs: The distribution of costs may be important, particularly in the final details of the analysis. For example, it may make a big difference whether repairs and rehabilitation of on-site systems are the responsibility of the management district, or of the individual householder. Consider the case of a community which is partly served by sewers and treatment plant, and partly by on-site systems with a management district. The community could lump all costs together and charge a uniform user fee. Alternatively, it could charge those in the sewer service areas their portion of the total costs, and those in the on-site area their portion. Issues related to distribution of costs are likely to be extremely significant politically.

Environmental Impacts: These must be considered, and there are two types of direct impacts that are likely to be of interest. One is the direct environmental impacts of the facilities, which are probably small. All facilities are assumed to meet water quality standards, assuming proper design, construction, and operation so the comparisons will be between facilities which exceed

standards by different amounts, or which discharge to different water bodies. Some consideration of aerosols, odors, facility esthetics, and the like may be required. The second type of direct impact consists of short-term problems arising from construction, and these are also likely to be insignificant.

More important than the direct impacts, though, are the indirect ones, which require some measure of land use change. If wastewater facilities change the capacity of an undeveloped area from 100 new homes before the sewer to 500 after construction, this should be identified. The same is true if the shift is from 100 to 50. Such shifts can affect land values, of course, but they can also affect future growth patterns, and the demands for other services. Impacts on land use and development should be estimated as part of the screening process, and stated as part of the final evaluation and recommendations. This is an area where public participation is likely to be of critical importance. Land use change may be the source of all the major environmental and socio-economic impacts in some areas, and needs to be considered throughout the evaluation.

6.2 SYSTEM STRUCTURE AND DISCHARGE POINTS

In most small communities, there are relatively few options for where to discharge the waste. In two of the three case studies, for example, the discharge points were fixed, and the major issue was the extent of sewering (a question addressed in detail in Section 6.3). In communities such as these, where natural conditions and existing constraints severely limit the disposal options, this stage of the evaluation can, in fact, be eliminated.

On the other hand, some communities are as complicated as the Milltown case presented in Exhibit 6-2. Several different choices may exist for each problem area, ranging from waterless toilets and graywater discharge, to connection to a large-scale sewer system with downstream discharge. The first step in such cases is to identify a range of possible alternatives, using the results of the previous chapter. The presentation does not need to include all combinations; instead, it describes a limited set of choices which show certain characteristics (e.g., maximum use of on-site system; maximum use of group subsurface disposal; maximum extent of sewering).

These system concepts can be defined in a number of ways. However, it is likely that the major evaluation factors can easily be derived from public input. For example, one natural dimension along which to design such concepts is the level of centralization, which can be translated into the extent of sewering of problem areas. Several concepts can be developed which show different amounts of centralization, with all such concepts solving the problems in each area. Another dimension of interest may be the ability of the system to serve new growth, which is likely to be a concern in many communities. Various concepts can be prepared which will affect the potential for new development, and these can be presented to the Board for review. In any case, each concept should be defined to include:

- an acceptable generic option for each problem area;
- any necessary management or facilities for non-problem areas;
- disposal sites for all effluents and residuals.

Exhibit 6-2, p. 1

SYSTEM CONCEPTS FOR MILLTOWN

Milltown is an extremely complicated small community for wastewater management, with 10 district problem areas and a large number of non-problem areas (largely undeveloped). In generating community-wide alternatives, several options for the individual problem areas were developed using the methods of Chapters 4 and 5. These were arrayed as shown in the first table. Solutions were then chosen which would make the maximum use of on-site sysetms, and which would maximize centralized treatment and disposal, as well as four intermediate concepts, also shown in the tables and maps.

Rough costs were developed for each system. These showed that concept #6 was much more expensive than the others.

A map was prepared showing the areas where excess capacity in the centralized system would be likely to have the strongest effect on growth, by highlighting the undeveloped areas close to the proposed trunk lines. Much of the work in this stage was directed at determining whether the potential discharge sites for the individual problem areas were actually available, and acceptable. Sites for subsurface disposal were found for all the suggested locations, but no land application sites could be found for problem area #1. Since the costs of treatment and stream discharge for that problem area did not appear to be extreme, the land application option was eliminated there.

The results of this stage can be summarized as follows:

- concept #1, with its dependence on retrofit of on-site systems, was unacceptable to the community;
- concept #6, maximum sewering, was undesirable because of its apparent high cost and its potential for induced development;

Exhibit 6-2, p.2

MILLTOWN COMMUNITY-WIDE CONCEPT DEVELOPMENT

Problem Area	Community-Wide Concept					
	1	2	3	4	5	6
1	E-K	E-K	K	A	A	A
2	C	B	B	A	A	A
3	C	B	B	A	A	A
4	D	B	B	A	A	A
5	E	B	J	B	A	A
6	H	B	B	B	B	A
7	B-C	B-C	F	F	F	A
8	E	B-C	B-C	B	B	A
9	D	B	B	B	B	A
10	B	B	G	A	A	A

A Convey to treatment outside area

B Convey to common SAS

C Mounds where required

D Water conservation and retrofit alternating SAS

E Waterless toilet; use existing system for graywater

F Connect 4 more houses to existing sewer system and common septic tank, install common SAS.

G Treat for direct discharge

H No action until failures

J Convey to package plant for land application

K Convey to treatment plant, with disposal by rapid infiltration

Exhibit 6-2, p. 3

SUMMARY OF COSTS FOR EACH CONCEPT

(thousand $)

	Community-wide Concept					
	1	2	3	4	5	6
Capital costs	$1,468	4,373	4,979	6,581	7,106	9,545
Federal/state grants[1]	1,380	4,111	4,681	6,186	6,680	8,972
Local Capital costs	88	202	290	395	426	573
Annual O&M	101	121	160	165	176	154
Annual O&M + Debt Service[2]	111	151	194	211	226	323
Present Value	3,543	6,503	7,083	8,452	9,033	12,010
Ranking	No[3]	Yes	Yes	Yes	Yes	No[4]

[1] 94% of construction costs without salvage

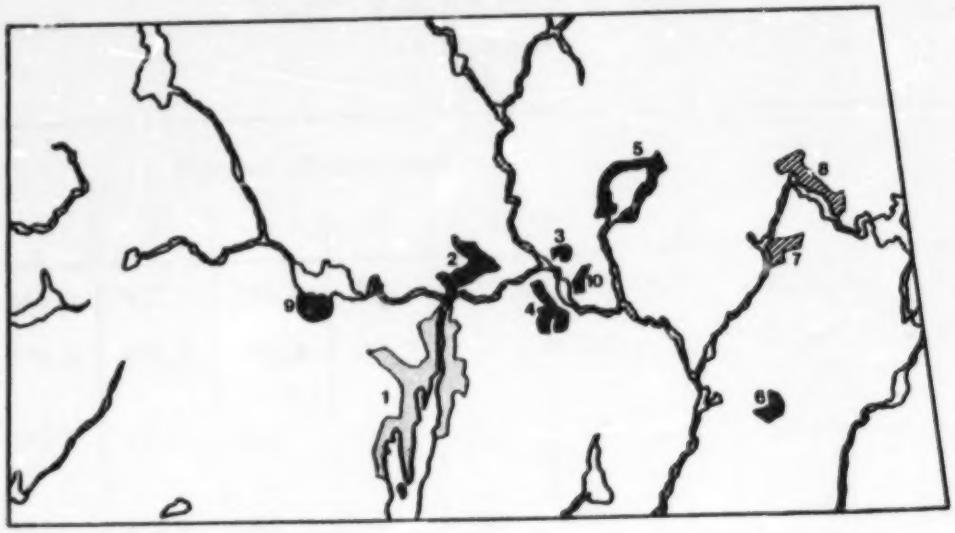
[2] at 6 5/8% for 20 years

[3] technologies unacceptable to the public, based on open meetings

[4] too expensive

Exhibit 6-2, p. 4

CONCEPT #2: ON-SITE AND COMMUNAL SYSTEMS



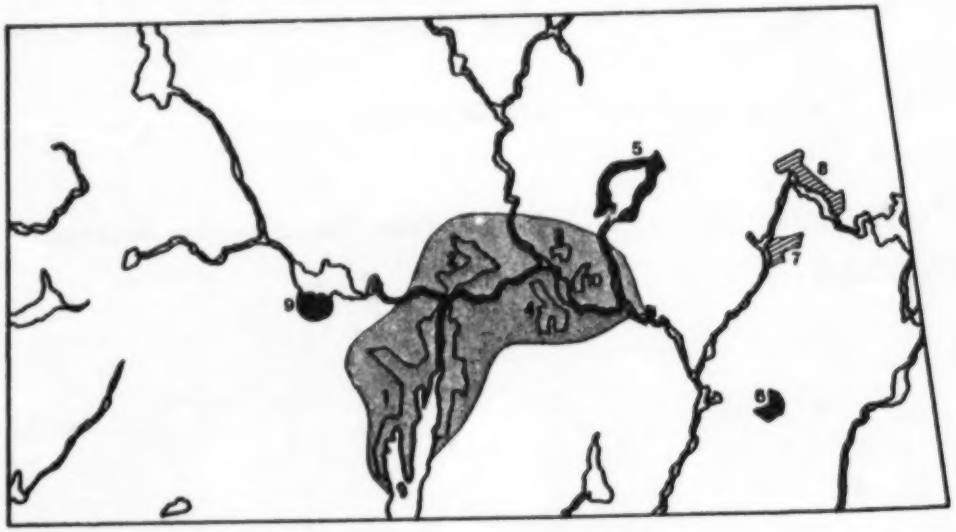
Sewer to Treatment and Land Disposal

Sewer, Common Disposal Field

Add Common SAS and Mounds

N

CONCEPT #4: CENTRAL SEWER SERVICE AREA



Sewer, Common Disposal Field

Sewer Service Area

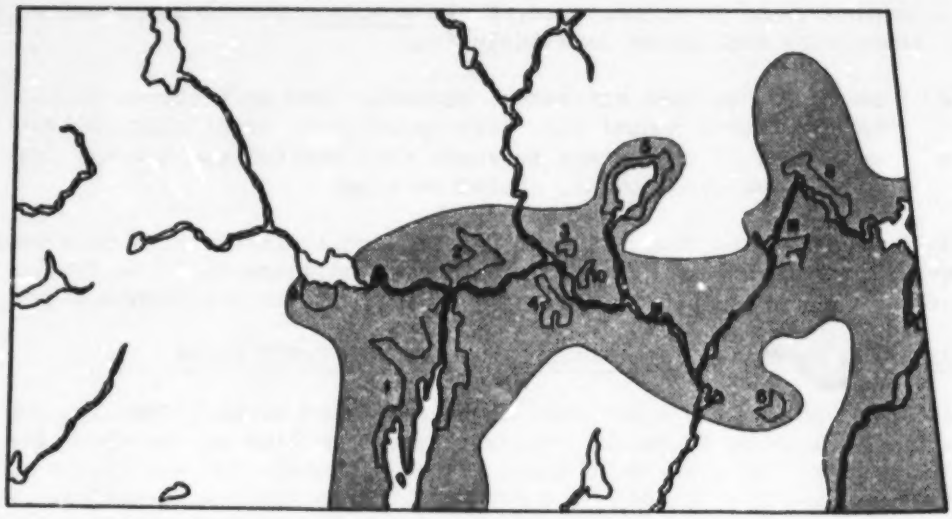
Add Common SAS and Mounds

N

Treatment Plant

Exhibit 6-2, p. 5

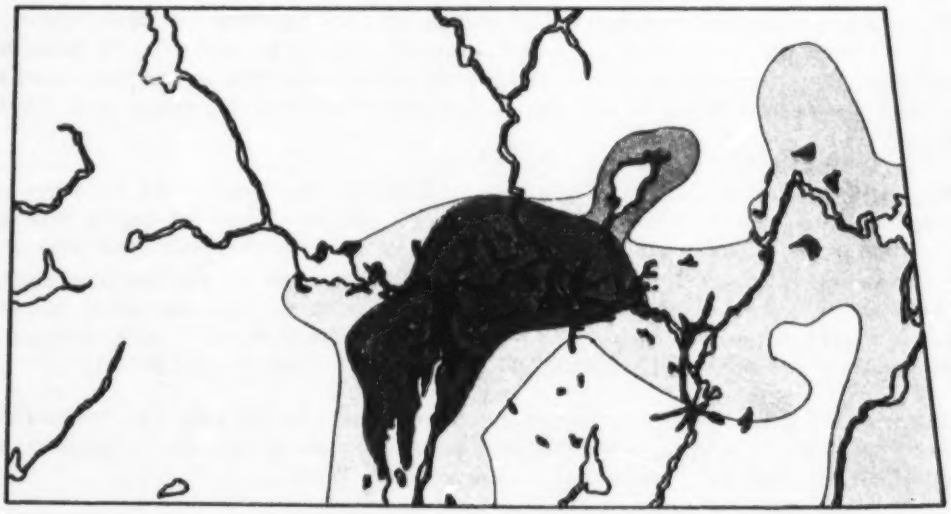
CONCEPT #6: MAXIMUM CENTRALIZATION



Sewer Service Area ■ Treatment Plants

N

POTENTIAL SEWER SERVICE FOR UNDEVELOPED AREAS



Developed Areas

Sewered in Concepts 4, 5, & 6

Sewered in Concepts 5 & 6

Sewered in Concept 6 only

Unsewered: serve with on-site

N

This step can be complex, as shown in Exhibit 6-2. On the other hand, it may be relatively simple, almost to the point of being trivial, as shown for Seatown in Exhibit 6-3. In either case, these concepts should be presented to the Board, along with evaluation data including:

- rough system cost estimates, probably from cost curves (total capital cost, annual O&M, life cycle cost, grant eligibility);
- estimates of the extent to which each concept could serve projected new development, shaded on a map.

By clearly stating the constraints and resulting limitations in this step, the engineer helps the community reach a concensus on where to focus future analysis. This concensus is the basic goal of this step in the methodology.

6.3 DEFINING APPROXIMATE BOUNDARIES FOR SEWER SERVICE AREAS

This stage in the analysis may have to be performed twice. Ideally, one would choose the area to be served by sewers at the same time as one chose the transport technology. However, both steps are complicated, and the analysis quickly becomes unwieldly. In defining sewered area boundaries, therefore, it is useful to initially work with whatever transport technology appears likely to be least-cost, and then check the results once technologies are selected in the next step.

The goal of this step is very simple: to define the extent and maximum flow of all sewer service areas for each concept, and to determine how much of the community will continue to use individual on-site systems. To do this analysis, it is necessary to identify a range of sensible options for the various sewer service areas, preparing estimates of costs and of impacts on development. Explicit decisions on time-staging and on excess capacity should, if possible, be addressed later. However, the projected sewer service areas may include undeveloped land, and this would raise issues of excess capacity and funding eligibility.

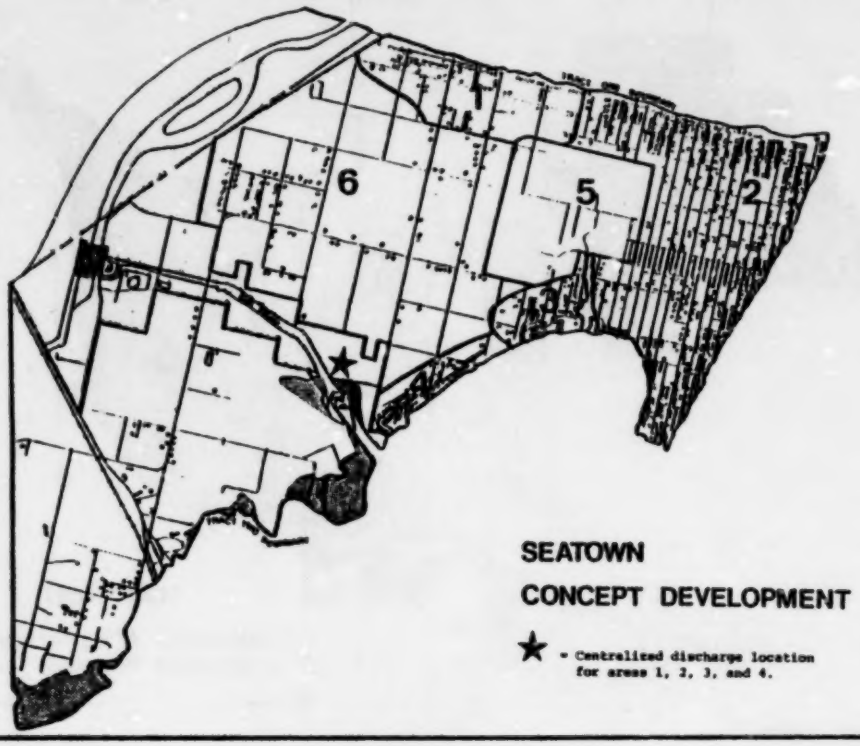
In some cases, such as Exhibit 6-4 for Hilltown, the number of options may be quite small. In others, there may be several options open to serve the existing development, and even more when extensions to undeveloped land are considered. Some of these options may involve combinations of collection technologies including conventional gravity, effluent pump or grinder pump pressure, vacuum, or small diameter gravity sewers. The cost analysis must include both eligible and ineligible costs with the local cost highlighted.

Two concerns are paramount for determining the extent of sewers: tradeoffs between centralization and on-site technologies for existing development; and extension of sewer service areas into undeveloped land.

The major difficulty is determining what level of detail on sizing and cost-effectiveness is necessary for the task of defining sewer service areas. The following procedure has been developed for optimizing the size of each sewer service area.

First, the desired range of sewer service areas for the community should be mapped on the basis of the concepts developed earlier. Then for EACH SERVICE

Exhibit 6-3

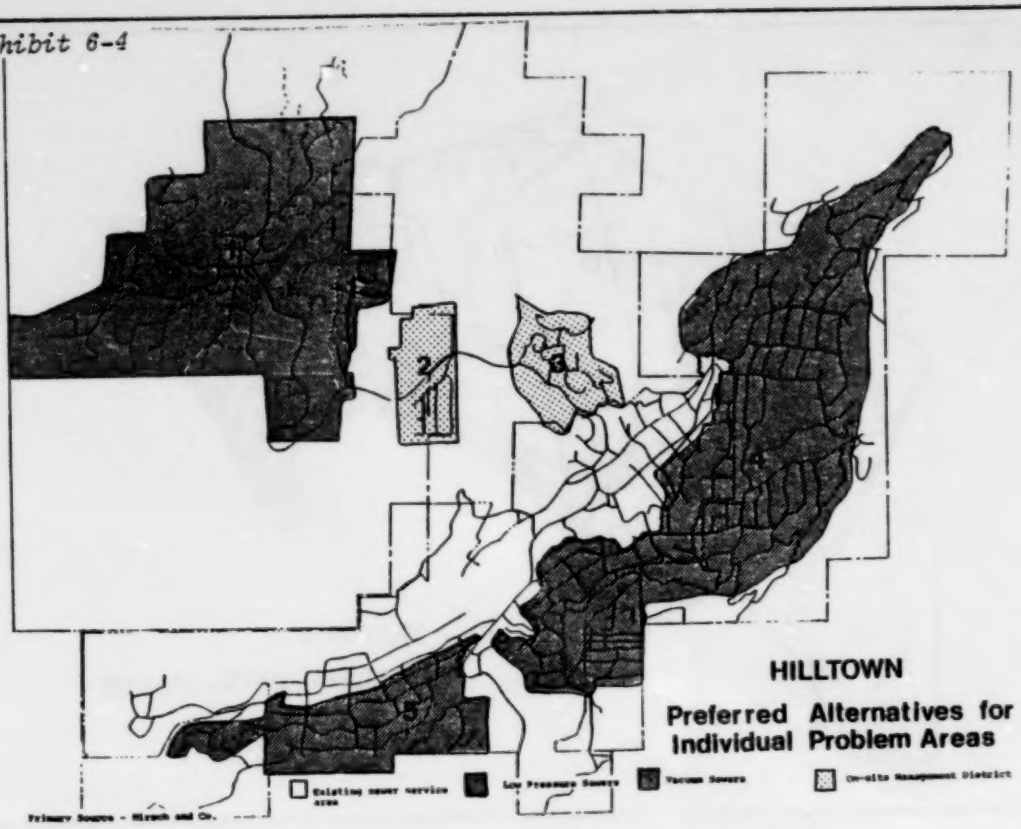


CONCEPT DEVELOPMENT FOR SEATOWN

The Seatown analysis is probably typical of the level of effort required in this step of the community-wide evaluation and was, in fact, trivial. There was only one feasible discharge point for a wastewater treatment plant: in the cooling water input channel for the power plant (another community uses the output channel). Land application was not feasible, because of wet climate, high groundwater table and poor soils. Continued use of on-site technologies was only possible in problem areas 5 and 6, given current problems in areas 1-4. While surface water discharge options, such as long discharge pipes, could have been investigated, it was clear upon minimal analysis that the channel was the most reasonable surface discharge point. The major issue was how far to extend sewers, a question which is a major topic of the next stage of the community-wide analysis.

Therefore, there is only one concept developed here: discharge of all collected wastes into the power plant cooling water input channel after treatment to secondary quality. This concept is shown on the map.

Exhibit 6-4



CHOOSING SEWER SERVICE AREAS FOR HILLTOWN

The map shows the preferred alternatives for the individual problem areas in Hilltown, with the major developed areas (#s 1, 4, and 5) served by collection and secondary treatment. The two smaller central districts (areas 2 & 3) would be served by individual on-site systems with management. The concepts developed in the first stage of the analysis included:

- *separate sewer systems for areas 1 and areas 4 & 5, with on-site management in areas 2 and 3;*
- *sewering of all areas, with a single plant.*

The use of an on-site district for all problem areas was rejected because it would not solve existing problems: many of the systems could not be brought up to standard with management and rehabilitation. Such a district would, however, be better than nothing, so it was recommended as a short-term option.

In the western area, three levels of sewer service were considered in the first stage: local subsurface disposal, centralized land ap-

plication in the area, and transport outside the area. The first was rejected because of land acquisition problems, since there are few areas in Hilltown with acceptable slopes, and those are prime development sites (or already developed). Centralized land application was possible, but suitable sites were unavailable; building a treatment plant as a precursor to land application was evaluated, but would have been much more expensive than transport to the eastern areas.

Therefore, the only available concept was centralized service, serving both the eastern and western areas of the community. The existing treatment plant and disposal areas would be expanded to treat the wastewater from both areas. The remaining questions were related to the actual extent of service at the edges, and in problem areas 2 and 3.

Given that an interceptor from area 1 to the treatment plant would have to pass through areas 2 and 3, marginal analysis showed it cheaper to connect these areas than to perform frequent rehabilitation of failing on-site systems.

Marginal analysis could also have been used at the edges of the proposed sewer systems, but this was dispensed with by using a rule of thumb: since the problem in the area was soils of low permeability, it was assumed a density of one house per two acres was acceptable, and that on-site disposal could be performed for these low-density lots at less cost than sewering. This assumption will be checked in the detailed design studies for Step II of the grants process and is only a simplification for planning. The result is that areas developed at higher densities were provided sewer service, with on-site management for the low density sites.

Thus, the problem area alternatives were quickly reduced to one system concept, where technologies could be compared: general collection and transport to an expanded treatment plant with land application at the current site.

AREA the engineer should:

- order the options from smallest to largest extent of service;
- estimate the population served in each service option, based on the future community growth (work with the local officials).
- take the smallest option and - using the most promising collection and treatment technologies - estimate collection and treatment costs for the design population;
- do the same for the next smallest option. Then compare the following costs:
  a. cost per household served, for the larger service area
  b. cost per household served for the same area, but with only a portion sewered. This will be a weighted average of the per household costs for households served in the smaller sewer service area and the per household costs for conventional on-site systems for the remaining household.
- if the cost per household for the larger option for that service area is lower than the cost per household of the smaller sewered option (plus necessary on-site systems), proceed to the next larger option and repeat the comparison; if the cost is higher, stop and select the least cost option.

By the marginal analysis approach, it should be possible to select the best size for each service area, though this may not be best when all service areas are considered together. Exhibit 6-5 provides an example of this marginal analysis approach for a hypothetical service area.

Once the best sizes have been selected for each service area, the engineer should work with local officials to allocate the projected growth over the next 20 years among the sewer service areas and the areas served with individual systems (see Exhibit 6-6). Total costs and local shares should then be compared among community-wide systems, using the service area boundaries developed. The result will be an estimate, for a given sewer technology, of how far sewer service should be extended for each service area, and this is the desired output for this stage of the process.

6.4 TECHNOLOGY SELECTION

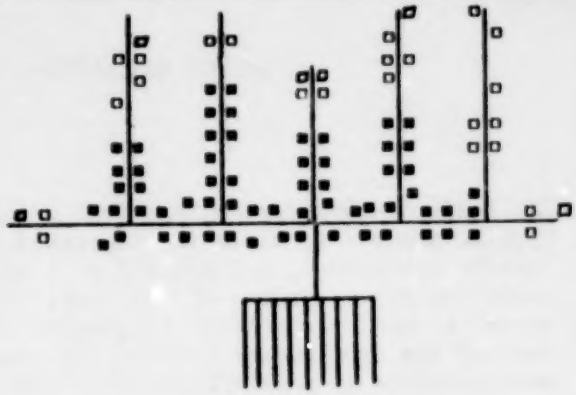
By this point, the sewer service areas, if any, and the possible points of wastewater disposal have been defined. Thus, this step is directed at defining the technologies to be used for each subsystem of wastewater transportation, treatment, and disposal, either on-site or centralized, as well as preparing detailed cost estimates.

The collection systems must be laid out for the areas served, and elevations identified to determine pumping requirements. Alternative collection technologies must be considered in this cost analysis where applicable, though consistency across areas is useful. This is the focus on the Hilltown example,

Exhibit 6-5

□ + ■ = Units in extended service area

■ = Units in basic service area



AN EXAMPLE OF MARGINAL ANALYSIS OF SEWER SERVICE AREAS

Consider the extended and basic sewer service areas show in the map. In the extended, 90 households are served by collection and centralized disposal. In the basic, only 60 households are served by the same technology, reduced somewhat in size; the other 30 are distributed around the community in areas where conventional on-site systems are acceptable.

The cost per household for the extended system was estimated at $3800. Because of economies of scale, the unit cost for the basic system was $4700. However, the costs per household of conventional on-site in acceptable areas was only $1500.

To compare the costs of serving all 90 households under the two systems, it is useful to look at either total costs or a weighted average:

Service Area	Technology	Units Served	Unit Cost	Cost
Basic	Sewered	60	$4,700	$282,000
	On-site	30	1,500	45,000
	Mix	90	3,633	327,000
Extended	Sewered	90	3,800	342,000

While the difference is not large, the cost of the smaller sewer system including the cost of on-site systems for residences not connected is less than the cost of the extended sewer system. In addition, limits on grant eligibility for capacity to serve new growth may increase the local share for a system serving the larger service area, accentuating the difference.

Exhibit 6-6

GROWTH ALLOCATION IN SEATOWN

The basic concept for Seatown involved providing sewer service to problem areas 1-4, while leaving problem areas 5 and 6 served by on-site management, and zoned for relatively large lots. The table shows how future growth was allocated to the individual problem areas to meet the project population for the year 2000. Here, much of the development goes to the coastal areas at high densities, made possible by provision of sewer service; most of the remaining development is placed in problem area 6, where the soils are relatively good, and where there is good transportation to other parts of the region.

The engineer can develop a tentative allocation such as this, but it is important to have such allocations approved by the Board. Decisions on the allocation of future growth are likely to be politically important, but are also necessary for the sizing of wastewater collection and transport networks.

SEATOWN GROWTH ALLOCATION

Problem Area	*Population in 1976*	*New Growth*	*Population in 2000*
*1**	*465*	*288*	*753*
*2**	*2218*	*2382*	*4600*
*3**	*162*	*309*	*471*
*4**	*241*	*418*	*659*
5	*0*	*185*	*185*
6	*297*	*595*	*932*
Track II	*213*	*187*	*400*
Total	*3596*	*4404*	*8000*

**Sewered*

shown in Exhibit 6-7. At the same time, options for wastewater, sludge, and septage treatment must be evaluated and estimates made of unit costs, which should be more detailed and site specific than the generic ones of the earlier stages.

To do both of these analyses, it is first necessary to estimate the required capacity for each collection and treatment system, using the anticipated development patterns from the previous stage.

For the comparison of technologies, the engineer should usually assume that time-staging is irrelevant, and work with the design population. In other words, assume that the optimal mix of technologies to serve the full community at the end of the planning period will also be the best choice now. Time-staging to reduce current costs will be considered later, in the final stage of the evaluation (Secton 6.5), since it should not affect the choice of systems--only the decision of what to build now.

The evaluation criteria include:

- cost, both total and local share (including public and private);
- local environmental impacts of the facilities;
- ease of operation and maintenance (which includes use of similar technologies wherever possible);
- public acceptance;
- performance (and risk).

Since the systems are well-defined at this point, the cost analysis can follow the EPA Cost-Effectiveness Analysis Guidelines (except for time-staging and other cost reduction measures). Complete costs should be estimated, grant-eligibility should follow the Guidelines, planning horizons and salvage values should be chosen as applicable for the technologies. All costs should be included, whether public or private, (including, for example, house connections). In other words, the evaluation should follow Step 1 requirements.

It may be necessary to repeat some of the earlier analyses at this point. For example, extremely high land costs for disposal within a problem area could imply that it should be served by an outside facility rather than a series of communal drain fields. Similarly, analysis of pressure sewer collection might also show benefits from expanding the sewer service area, which was defined based on the costs of gravity systems. Or, public comment might lead to changes in the handling of future growth. However, these iterations should be limited in scope, so that the goals of this stage can be achieved.

Some of the analyses in this step can be piecemeal. For example, it is possible to take a given wasteload and set of disposal requirements and estimate the costs of a number of different treatment options; the same is true for collection technology. The only interaction arises when the collection systems being compared handle different types of wastes (e.g. conventional gravity sewers carrying raw sewage compared to small diameter sewers carrying septic tank effluent).

Exhibit 6-7, p.1

TECHNOLOGY SELECTION IN HILLTOWN

Three technologies were considered for wastewater transport for Hilltown, under the assumption that the existing treatment plant and disposal system would be expanded to serve the additional loads:

- *o conventional gravity sewers;*
- *o low pressure sewers with grinder pumps;*
- *o vacuum collection systems.*

For all options, septage disposal was assumed to be effected at the expanded treatment plant. STEP pressure sewers, with lower maintenance costs than grinder pumps, were eliminated by the engineer because of the expected high costs for replacement of existing septic tanks.

The first table presents the present worth for the capital costs, and also for operations and maintenance, based on Federal grants of 75% for the conventional gravity sewers and 85% for the pressure and vacuum sewers and the treatment plant, plus state grants of half of the remaining grant eligible amounts in each case. The lives for all sewers are assumed to be 50 years, with salvage values computed after 20, and costs for replacement of short-lived items such as grinder pumps are included in the annual O&M. The table shows the total present worth for the system and the present worth of the local share, as well as the local costs per household per year (all in constart dollars).

Note that all costs include the house connections ("service laterals") and that all systems have the same number of households served. All systems also transport all wastes from the households. Thus, while the cost analysis does not include costs in the unsewered areas, the costs are consistent across all options.

On the basis of this analysis of technologies, vacuum sewers were selected as the recommended option from this stage of the evaluation. They were also believed in this case to lead to less construction impact than conventional sewers, and to have similar maintenance requirements to the grinder-pump pressure sewer option.

The potential costs for serving new growth were analyzed for the three systems by looked at the incremental costs of new services, as shown in the second table.

Exhibit 6-7, p. 2

HILLTOWN COST SUMMARY	Transport System: CONVENTIONAL GRAVITY	PRESSURE	VACUUM
Total Present Worth	$11,102,284	$8,523,577	$7,936,520
Grant Eligible Amount	8,678,200*	6,283,381	5,829,520
Conventional Grant at 75%	5,554,720	---	---
Alternative Grant at 85%	1,092,454	5,340,874	4,955,092
State Grant	1,015,513	471,253	437,214
Present Worth to District**	3,449,497	2,711,450	2,544,214
Present Worth Per Residence	2,029	1,595	1,497
Average Monthly Charge Per Residence	15.97	12.56	11.78

*1,285,240 at 85% (sewage treatment plant and a few grinder pumps in outlying areas); $7,392,960 at 75% (gravity sewers).

**Total present worth minus State and Federal grants.

	Incremental Costs for New Households (Present Worth)			Total Local Present Worth: Existing and New Users
	Construction	O&M	Total	
Gravity	$ 66,236	$10,000	$77,036	$3,526,533
Pressure	$206,985	$69,733	$276,718	$2,988,168
Vacuum	$ 84,815	$69,733	$154,548	$2,698,762

Here, it was assumed that the new development would fill in undeveloped lots, near the wastewater transport network. The new construction costs for gravity sewers would be for service laterals, while the pressure system would require 200 new grinder pumps, with associated O&M. For the vacuum system, no new central vacuum stations would be required, though valves would be necessary at the households. It was assumed that short-lived equipment would require maintenance, and that pumping costs would increase because of the increased flows.

Thus, the incremental costs to serve new development were lowest for the gravity sewer system, and highest for the pressure sewer system. Since it was assumed that the new development would not be grant eligible, these costs are added directly to the local share. However, they do not shift the relative rankings of the three systems, so the vacuum system was selected.

One important criteria is that the systems be both operable and maintainable; another is that they be likely to work. At the very least, these criteria imply that the various systems in the community be compatible: that, as much as possible, similar technologies are used throughout. While the Exhibit 6-4 for Hilltown showed three types of collection technologies as optimal for three types of areas, Exhibit 6-7 selects a single technology to be added to the existing system.

Innovative technologies involve more risk than conventional or alternative technologies, and this would, in the abstract, be a drawback. However, the Federal government has decided to absorb some of that risk, in an attempt to develop and demonstrate these innovations. The big risks for the community come not when the proposed system is innovative, but when the choice is a conventional system which should work in theory, but is poorly designed or badly operated. Thus, ease of operation and maintenance is desirable for any treatment or transport system.

The compatability of the technologies is also a factor in sludge management. In most small communities, septage disposal will be a consideration, unless all areas are served with sewers carrying unprocessed wastewater. On the other hand, STEP sewers might be desirable if only a small part of the community is served, because septage collection and treatment would be required for the individual systems. This septage collection system could easily be extended to the sewer service area as well. If the plan calls for septage to be landspread, and a compatible sludge from wastewater treatment can be generated, the same systems for stabilization and disposal could be used.

Environmental considerations apply in this stage as well. In the choice of technologies, issues such as construction impacts are likely to be extremely important. In addition, localized impacts such as odors and esthetics may be the deciding points between various treatment and residuals disposal options. Public participation in this step will allow the engineer to assess how important these impacts are in the particular situation, along with providing more information about the ability of the community to operate and maintain the suggested systems. While several concepts may still be under consideration, it is necessary that the technologies fit the needs of the community. Public participation is one of the best ways to evaluate these community needs.

The result of this stage of the analysis will be a set of well-defined systems with identified service areas and technologies, which could serve the population at the end of the 20-year planning horizon.

6.5 MANAGEMENT, COST ALLOCATION, AND DETAILED EVALUATION

The final stage in the analysis of community-wide systems, and in the preparation of the Step 1 plan, is to take the systems defined by the earlier stages and perform a detailed cost-effectivenesss and environmental evaluation on them, repeating earlier steps if improvements can be made.

Where the installation of a sewer system has been deemed necessary, it has been general practice to consider in the cost-effective analysis only the costs related to providing the sewer services. However, there are usually

many existing units outside of the service area which will continue to rely on on-site systems. In order to make a fair comparison between various community-wide options it is important that the costs of maintaining and ultimately replacing these systems must be considered. Even if the responsibility for individually-owned systems remains exclusively with the owner, capital costs for individual systems installed by developers should be estimated. It is particularly important that provisions be made to insure the long term operation of these outlying privately-owned systems in order to avoid the public costs associated with connecting such units to a collection system in the future.

The Cost-Effectiveness Analysis Guidelines* require that options be analyzed for their full costs, which is interpreted here as the full costs of wastewater service for the complete community, including maintenance of existing and future on-site systems. It requires consideration of time-staging of construction, which is straightforward given the following:

- o the initial population
- o estimates of scale economies, and
- o the desired system structure at the end of the planning period.

Therefore, all the necessary information for the cost-effectiveness analysis is available from the earlier stages of the process.

The same is true for the analysis of direct and indirect environmental impacts: for each concept, all sites have been located, and technologies have been chosen for them. Locations of projected new development have been defined for each option, and excess capacity for growth can be estimated from the sizes of the various transport and treatment facilities. Therefore, it is possible to map where extra development is feasible under each option, and present these results. Exhibit 6-8 provides an analysis of growth issues for Seatown. An excess capacity map can be used along with methods for estimating municipal service costs (school, police, etc.) to evaluate the local costs of growth above or below the design level.

The institutional aspects, however, remain to be defined. One institutional issue is cost allocation. In presenting the results, it is useful to present costs for an average resident in the community, but it is even more useful to present the actual expected costs to each class of residents. In this stage, therefore, alternative cost sharing arrangements should be defined, and estimates made of how the system costs will be allocated to those provided with different types of service. In other words, the operations and maintenance arrangements and financing methods must be selected, with alternatives presented to the community. In many cases, this is fairly easy: the wastewater district should own and manage any centralized facilities, so the major questions arise with respect to on-site and communal systems. These can be privately owned and managed under a permit system, privately owned and publicly managed, or publicly owned and managed. In the first case, the resident must comply with regulations, but pays all costs for maintenance, pumping, and --where necessary--rehabilitation. In the second option, the resident pays user charges to the local district, which performs the necessary maintenance, though this probably does not cover rehabilitation. In the final option, the

*Appendix A of 40CFR35.

Exhibit 6-8 PLAN	MAXIMUM SYSTEM CAPACITY (Persons)			CAPITAL COSTS (Million $)		
	coastal	central	total	local	federal	total
Fully grant-eligible system	8,520	1,412	9,932	0.36	2.04	2.40
Increased interceptor and pump capacity	12,000	1,412	13,412	1.16	2.04	3.20
Addition of interceptors for the Central areas	12,000	6,000	18,000	2.66	2.04	4.70

POTENTIAL FOR GROWTH IN SEATOWN

After the initial negotiation with the grant officials, it was agreed that the grant-eligible design population for Seatown would be 8,000. However, the community was still interested in considering the provision of service to accomodate a population of up to 18,000 by the year 2000. The Board asked the engineer to analyze the local cost of providing the additional capacity.

The engineer first analyzed systems designed to meet the needs of the grant-eligible population based on the allocation of expected growth described in Exhibit 6-6. The recommended plan called for conventional gravity sewers and secondary treatment for the Coastal problem areas, with continued use of septic tanks with alternating SAS (either individual or cluster) in the Central problem areas.

In the Coastal areas, the actual capacity of the proposed sewer system was somewhat greater than the design population because of hydraulic design constraints. With relatively minor changes in interceptor sizes and pumping station capacity the overall capacity of the sewer system could be increased at a low marginal cost (although the local share of capital costs triples).

The engineer also evaluated providing additional excess capacity at the treatment facility at this time as opposed to staging it to meet future needs, and looked at the cost of providing interceptors for the central areas as an inducement to growth.

While it was not cost-effective to provide the excess plant capacity at this time, the three options for the transport system were presented to the community, and are shown in the above table.

public body provides wastewater service for all households and collects user charges to pay for the service. All construction, operation, and maintenance tasks are performed by the public agency, or firms under contract to it.

However, these are just the basic classes of arrangements, and the details are extremely important. These details need to be evaluated for the particular case by the engineer, and presented to the community. Costs for the various options may be affected slightly by the organizational arrangement, and the distribution of costs depends greatly on the financing methods chosen. For example, in the above list, on-site system failure can be the responsibility of either the resident or the community; similarly, the costs of larger facilities can be paid by the people using those particular facilities, or by the community as a whole since all receive service of equal quality.

Exhibit 6-9 presents the distribution of costs under various institutional arrangements for Hilltown, using the vaccum sewer option. Besides the cost allocation, there are a number of other institutional considerations which must enter in this step. The primary one is that every necessary component of system design, installation and operation must be provided by some part of the institutional structure. Exhibit 4-11 showed the necessary management functions, and was suggested for us as a checklist to analyze the powers and responsibilities of the various existing institutions. It is repeated here as Exhibit 6-10 since the engineer must ensure that each of these management functions is the responsibility of some institution, though this may require establishing some new institutional arrangements.

Institutional issues such as these need to be decided here, since this is the final evaluation step. At this point, technical options have been analyzed for each problem area, and used to identify system concepts. Those concepts have been developed into complete wastewater management options by first analyzing disposal sites and overall characteristics of the concepts, then choosing a reasonable range of sewer service areas, selecting technologies for collection, treatment and disposal, and finally evaluating the cost-effectiveness, environmental impacts, and institutional arrangements for these full systems. All that is left is for the community, through the wastewater agency and the public meeting, to select the best available system and submit the Step 1 plan.

6.6 FINAL RECOMMENDATIONS

It is assumed here that the engineer is familiar with the requirements for a Step 1 plan, which vary somewhat from state to state. The previous section followed the methodology to the point of preparing detailed cost and environmental impact assessments of the best alternative systems for the community, and developing recommended institutional structures. At this point, it is time for the engineer to present these data to the Board for selection of the recommended plan, and to present the recommended plan and alternatives to the community at the public hearing. Given an effective public participation program throughout the planning process, though, this should be relatively straightforward.

The Step 1 plan, with its associated environmental assessment, must be signed by the Board, since the Board was designated by the community as the responsible

Exhibit 6-9

DISTRIBUTION OF COSTS IN HILLTOWN

There are innumerable ways to charge for wastewater service. In a system such as Hilltown, involving an existing sewer system, a proposed system, and some households served by neither, the question of how the charges should be allocated is complex.

The total bill is about $270,000 annually; there are several options for dividing these costs among the residents in the community. One of the simplest is just to have a service district which provides all households with wastewater service, incurs all costs, and divides them equally: this would amount to an assessment of about $8.74 per month to all households.

If the district served only the sewered areas, the assessment for those served would be $9.42/month, and the average cost for those with individual systems would be about $6.20 per month. On the other hand, the range of costs for individual systems would be large, because of variations in pumping frequency and need for replacement. In any year some would pay nothing, others up to several thousand dollars.

A community-wide management district could even out these payments by dividing the costs for the few replacements each year among all users. With public ownership, the household would pay a fixed charge of $6.20 per month for a permit, annual inspection, pumping when necessary, and any rehabilitation or reconstruction which would be required.

In the sewered areas, the local capital costs could be paid in several ways, but the most common are

- *complete averaging among the users;*
- *costs allocated by water flow metering, and*
- *frontage and connection fees.*

In the first and second all costs are divided among all users, leading to the average assessment of $9.42/month. In the latter, households in the new service area pay for the feet of sewer line frontage they have, plus the full costs of their house connection line, plus a user fee (an average of about $10.43/month). Households

in the old service area pay any remaining debt service and interest, plus about $4.25/month in user fees.

Putting all these costs together for this option leads to the following:

- *New Sewer Service Area: average costs of service of $10.43/month, paid through user charges or through a combination of frontage, connection, and user charges;*
- *Old Sewer Service Area: user charges of $4.25/month;*
- *Individual On-Site Systems: an average of $6.20/month for permitting operation, maintenance, and replacement distributed very unevenly across the systems.*

Because high private costs for rehabilitation will lead to problems in replacing failing on-site systems, and because the community wishes to promote sewer connection in the areas where on-site systems are currently affecting water quality, it is recommended that the community implement options which equalize the costs across systems served in similar ways. There are three recommended options:

#1: Charge each type of user a class rate:

- *$6.20/month for individual on-site systems, including permits, inspections, maintenance, rehabilitation, and district management costs;*
- *$4.25/month for households served by the existing sewer system;*
- *$10.43/month for households served by the new sewer system and added plant capacity.*

#2: Treat all sewer system users equally:

- *$6.20/month for individual on-site systems;*
- *$9.42/month for sewered households.*

#3: Treat all users equally:

- *$8.74/month for all households, with the district taking responsibility for all costs except those caused by customer negligence.*

ON-SITE MANAGEMENT FUNCTIONAL RESPONSIBILITIES CHECKLIST

Exhibit 6-10 *(A completed form is shown as an example)*

	MANAGEMENT ISSUE	RESPONSIBILITY			REQUIREMENTS/COMMENTS
		Public	Private	Not Done	
DESIGN	Design Standards	✓			State Sanitation Code requirements incorporated into County Health Code; County has added requirements for alternating fields
	Design Engineer Licensing	✓			State requires that system designer be a licensed sanitary engineer or pass state certification test
	Site Feasibility Analysis	✓	✓		County requires deep pit observation holes in addition to state mandated perc. test; also requires soils analysis for certain sites; site analysis witnessed by county sanitarian
PLANNING	Plan Review	✓			County sanitarian reviews final plans within 45 days as per state sanitation code; systems >15,000 gpd in size forwarded to District Environmental Health Office for review; detailed plan requirements--copy enclosed
	As-built Plan		✓		County requires as-built plan be filed with County Health Department prior to occupancy permit issuance
	Coordination with other local boards	✓			Building inspector occupancy permit contingent upon County Health Department ok; the building inspector also screens dwelling unit changes for additional on-site system requirements
INSTALLATION	Installer Registration			✓	
	Performance Bond		✓		County requires installer to file a $2,000 performance bond with County; refunded after satisfactory system operation for 365 days
	Excavation Inspection			✓	
	Leaching Field--Fill Inspection			✓	
	Leaching Field-- Grade Inspection			✓	
	Backfilling Inspection				County sanitarion inspects backfilling operation; 48 hour notice required.
OPERATION	Occupancy Permit	✓			County Health Department must approve Building Inspector occupancy permit at each change of ownership in a dwelling unit.
	Public Education	✓			Brochure on appropriate user habits for on-site systems distributed at issuance of occupancy permit; also published semi-annually in local newspaper
MAINTENANCE	Pumping		✓		Occupany permit tied to a mandatory pumping of septic tank once every three years; notice mailed to occupant at appropriate time; pumpout receipt required to be mailed back within 60 days after pumping.
	Pumper Registration	✓			Private pumpers who serve homeowners are regulated by an annual registration form; required to return a copy of each form to county upon appropriate septage disposal
	Recordkeeping	✓			Through the occupancy permit renewal process and septage pumpout receipts, County is tracking performance of all systems; failures being correlated with user habits (through special survey) as-built plans and soils
MONITORING	Surface Water Quality Testing			✓	
	Groundwater Quality Testing			✓	
	Water Quality Monitoring	✓			County Sanitarian monitors nitrate levels for public wells that are in densely developed areas; water department conducts water quality analysis as per state requirements
ALTERATION	Repairs	✓	✓		County regulates all repairs as if they were new installations; same regulatory process must be adhered to
	Dwelling Unit Conversions/ Enlargements	✓			County Building inspector notifies County Sanitarian of dwelling unit changes for possible additional on-site disposal requirements
FINANCING	Installation Fee		✓		County requires a $75 fee for reviewing design plans, witnessing site feasibility analysis, and witnessing installation
	User Charge		✓		County levies a $25 user charge for the renewal of all occupancy permits to cover administrative expenses
	Annual Appropriations	✓			Health Department receives an annual appropriation from the County general fund for department budget

local body. In addition, the Step II application should be prepared at this time, though EPA must make a determination of whether an Environmental Impact Statement is required before the Step II grant application can be processed. Existing EPA guidance, and information provided by the State, should provide all the necessary instructions for these documents, which can be prepared based on the analysis employing the methodology described here.

APPENDIX A

UNIT PROCESSES AND TECHNOLOGY OPTIONS

TABLE NUMBER	TITLE
A-1	HOUSEHOLD WASTEWATER GENERATION, 127
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A-8	DISPOSAL OF SOLIDS, 137

TABLE A-1

HOUSEHOLD WASTEWATER GENERATION

FIXTURE	OPTION	EFFECT	COMMENTS
Toilet	Conventional water closet	-----	Effective; requires 4-5 gal. water per flush
	Low flush (2-3 gal/flush)	Moderate flow reduction; increased pollutant concentrations	Retrofit effective; well demonstrated
	Very low flush (<1 gal/flush)	Significant flow reduction; increased pollutant concentrations	Some units require small air compressor; retrofit effective; well demonstrated
	Waterless toilets: composting	Removal and treatment of toilet waste; significant flow reduction	Small units use heating element; retrofit with large unit may be difficult; residuals removal required periodically
	incinerating	Total combustion of toilet waste; significant flow reduction	High energy requirement; ash removed periodically
	Recycle toilets	Removal and treatment and/or storage of toilet wastes--significant flow reduction	May use oil or water--base flushing fluid; generally too expensive for individual homes; residuals removal required
Others	Pressure reducing valve	Moderate flow reduction; increased pollutant concentrations	Retrofit effective; well demonstrated
	Low-flow shower heads and flow restrictors	Low to moderate flow reduction	Simple low-cost retrofit; can be effective depending on user habits
	Faucet controls	Low overall flow reduction	Retrofit effective
	Water conserving appliances	Moderate to significant flow reduction	Retrofit effective; cost equivalent to conventional appliances
	Hot water pipe insulation	Maintains water temp. in pipe; moderate water savings	Retrofit may be difficult

TABLE A-2

ON-SITE TREATMENT ALTERNATIVES

OPTION	COMMENTS
Septic Tank	Well-demonstrated, low-cost; requires removal of septage every 3-5 years; effluent does not meet secondary standards
Aerobic System	Most systems well demonstrated; high O&M requirements; process control required; potential to produce secondary effluent; periodic sludge removal required.

TABLE A-3

ON-SITE EFFLUENT TREATMENT/DISPOSAL OPTIONS

OPTION	USE	COMMENTS
Filtration	Auxiliary treatment before surface discharge	Demonstrated; requires moderate operation and maintenance, pumping usually required
Disinfection	Before surface discharge	
Halogens		Not widely demonstrated; chemicals required
Ultraviolet		In development; high O&M costs
Ozone		In development; high O&M costs
Surface discharge		Demonstrated; relatively simple discharge outlets required; regulatory problems likely
Evapotranspiration	Transport of effluents to the air by evaporation and transpiration	Demonstrated; very climate sensitive; high land requirements in most installations; high construction costs
Soil absorption systems	Transport of effluent to groundwater by means of sub-surface application	
Conventional (leaching fields, trenches, chambers, pits)	Gravity distribution	Demonstrated effective in good soils; generally low cost compared to other on-site alternatives
Modified dosing tanks, pressure distribution	Provides for resting of soils and better effluent distribution	Useful in marginal solids to retard clogging; most significant in large systems (see 2.5); moderate O&M
Alternate fields	Provides annual resting of soils	High construction costs; demonstrated and effective
Mounds	Allows subsurface disposal in areas with high groundwater	High construction costs; demonstrated and effective
Treatment/Reuse	Toilet flushing, lawn watering, etc.	May be applied to segregated waste streams (e.g. greywater); many variations possible; may have high capital and O&M costs

TABLE A-4

TRANSPORT ALTERNATIVES

ALTERNATIVES	PHYSICAL CONSTRAINTS		COMMENTS
	CONSTRUCTION	OPERATION	
Conventional Gravity Sewers	A. Flat or changing topo and basement drains may require Deep Cuts B. Bed rock C. Groundwater	A. Place below frost line; lift stations may be required B. Deep Cuts, lift stations increase costs substantially C. Infiltration	Well demonstrated Advantages: No pretreatment required No on-site equipment required Public acceptance
Grinder Pump Pressure Sewers	A. Few restrictions on topo, bedrock, groundwater B. Requires grinder pump and holding tank for each connection to main	A. Place below frost line B. Power source required at each connection to main C. Pump maintenance	Concept and design well demonstrated. Additional needs in hardware and maintenance. Advantages: Uses small diameter plastic pipe installed near grade Cost is less dependent on site constraints No infiltration/inflow
Vacuum Sewers	A. Less constraints than conventional but greater than pressure	A. Place below frost line B. Vacuum valve at each connection to main C. Central vacuum pump	Needs demonstration: hardware, maintenance Advantages: Cost is less dependent on site constraints; reduces water use No I/I
Hauling (holding tank and truck)	A. Requires holding tank at each connection to main	A. Regular pumping of holding tanks B. Requires availability of treatment plant or land application site (winter storage)	Well demonstrated, but costly Advantages: Best suited for isolated residences without on-site disposal alternatives or interim handling

TABLE A-4

TRANSPORT ALTERNATIVES

ALTERNATIVES	PHYSICAL CONSTRAINTS		COMMENTS
	CONSTRUCTION	OPERATION	
Septic Tank Effluent Pump (STEP) Pressure Sewers	A. Few restrictions on topo, bed rock, groundwater B. Requires septic tank, holding tank and effluent pump at each connection to main	A. Place below frost line B. Power source required at each connection to main C. Pump and septic tank maintenance D. Odor control (?) E. Effluent treatment	Concept and Design well demonstrated: Additional needs in hardware, maintenance, effluent treatment and odor control. Advantages: Same as grinder pressure sewers plus pumps are less costly and somewhat easier to maintain. Partially treated effluent. No I/I
Small Diameter Gravity Sewers (Effluent)	A. Flat or changing topo and basement drains require Deep Cuts B. Bed rock C. Groundwater D. Septic tank required at each connection to main	A. Place below frost line; lift stations may be required B. Deep Cuts, lift stations increase conts C. Infiltration D. Septic tank maintenance E. Odor control (?) F. Effluent treatment (?)	Needs demonstration: scouring velocities/pipe slope maintenance, man holes/cleanouts, odors Advantages: Small diameter pipe, lower scouring velocities, potentially less stringent requirement for manholes

TABLE A-5
CENTRALIZED TREATMENT OPTIONS

Process	Objectives	Level of Process Control Required	CONSTRAINTS			Waste Stream Generated	Comments
			Land	Climate	Operation		
Preliminary							
Grit Chamber	Removal of grit, dirt	Low	Low	None	May be maintenance problem due to abrasion	Grit and dirt	Relatively simple process
Bar Screen	Removal of large solids	Low	Low	None	Same as above	Screenings	Relatively simple process
Preaeration	Odor control and grease removal	Low	Low	None	Requires O&M of aeration equipment	Scum	Relatively simple process
Prechlorination	Odor control and grease removal	Low	Low	None	Handling of chlorine	Scum	Relatively simple process
Comminution	Grinding of solids	Low	Low	None	Equipment durability; Stand-by unit required	None	Well demonstrated
Primary							
Primary Clarification	Removal of inert+ organic solids	Low	High	None	Solids must be removed	Primary sludge	Very well demonstrated
Fine Screening	Removal of inert+ organic solids	Low	Low	None	Solids must be removed; Equipment durability	Screenings	Well demonstrated
Secondary							
Anaerobic							
Septic/Imhoff Tanks	Sedimentation/ flotation sludge reduction	Low	Low, unit is subsurface	None	Periodic maintenance	Septage	Well demonstrated
Suspended Biomass (Biolytic Tank)	Sedimentation/ flotation secondary	Moderate to High	Low	None	Same as above	Sludge	Experimental, may be well suited to wastes with high BOD
Fixed Biomass (Submerged Filters and Discs)	Secondary and nitrogen removals	Moderate	Low	None	Requires pre-settled waste)	Sludge	Experimental
Aerobic Treatment							
Intermittent Sand Filters	Secondary or auxiliary	Low	High	Requires cover or special operation in winter	Requires auxiliary treatment; Requires pre-settled wastes, Alternate units may require power	Periodic sand and solids removal	Well demonstrated Simple, low cost
Fixed Biomass							
Trickling Filters	Roughing and secondary	Moderate	Moderate	Requires cover in winter	Pre-settled waste; May require power	Moderate biological sludge production	Well demonstrated; Simple, less susceptible to upset than suspended biomass; May be built above ground

TABLE A-5
CENTRALIZED TREATMENT OPTIONS

Process	Objectives	Level of Process Control Required	CONSTRAINTS			Waste Stream Generated	Comments
			Land	Climate	Operation		
Bio Discs	Roughing and secondary	Moderate	Moderate to low	Requires cover in winter	Pre-settled waste; Required power	Moderate biological sludge production	Well demonstrated for large flows
Emergent Vegetation	Secondary or auxiliary	Low to Moderate	Very high	Seasonal operation only	Pretreated	Crops	Demonstrated, needs more info on cold weather operation
Suspended Biomass							
Activated sludge (conventional and contact stabilization)	Secondary	High	Low	Treatment reduced in cold weather	Pre-settled waste best; Substantial power requirements	High biological sludge production	Well demonstrated Susceptible to upset from influent flow or quality variations
Extended Aeration	Secondary	Moderate to High	Moderate	Treatment reduced in cold weather	Less pretreatment required than conventional A.S.; substantial power requirements	Moderate to low biological sludge production	Well demonstrated; simple; Can accept raw waste; Less susceptible to upset
Oxidation Ditch	Secondary	Moderate	Moderate to High	Treatment reduced in cold weather	Odor control; Optional algae control for nutrient removal	Optional	Well demonstrated; simple; low cost
Stabilization Ponds	Secondary	Low	High	Treatment reduced in cold weather	Odor control	None	Well demonstrated; simple; low cost; effluent suspended solids may be relatively high preseration of septic effluents may be required
Auxiliary							
Polishing Ponds	Solids and organics removal removal	Low	High	Treatment reduced in cold weather	Odor control	None	Same as above
Filtration							
Low rate or intermittent sand	Solids and organics removal	Low	High to Moderate	Requires cover or special operation in winter	Alternate units; May require power	Periodic sand and solids removal	Well demonstrated; simple; low cost
Mechanically cleaned high rate, pressure, and upflow filters	Solids removal	Moderate to high	Low	None	Alternate units; Substantial power requirements	Solids carried in backwash water	Well demonstrated; O&M requirements
Recirculating sand filters	Solids and organics removal	Low	High	Special non-recycling operation in winter	Periodic maintenance; Requires a pump	None	Being demonstrated
Expanded Bed Biological Filters	Auxiliary treatment	Moderate	Low	?	Requires pretreatment of wastes; Requires power	?	Experimental

TABLE A-5
CENTRALIZED TREATMENT OPTIONS

Process	Objectives	Level of Process Control Required	CONSTRAINTS			Waste Stream Generated	Comments
			Land	Climate	Operation		
Chemical Precipitation	Solids and phosphorus removal	High	Low	None	Chemical feed equipment; Mixing, floculation and settling required; Power may be required	Increased sludge production	Well demonstrated; good for phosphorus removal; help in upgrading
Chemical Oxidation	Organic removal, odor control	High	Low	None	Handling of dangerous chemicals; Power required		Used only for special application
Ion Exchange	N and metal removals	High	Low	None	Media must be regenerated; Power required	Regenerate	More research need for wastewater applications. Susceptible to organic fouling
Chemical Adsorption	Solids and organic removal	High	Low	None	Media must be regenerated; Power required	Ash or regenerate	Well demonstrated; used only where extremely high quality effluent is required

TABLE A-6

CENTRALIZED EFFLUENT DISPOSAL

PROCESS	LEVEL OF PROCESS CONTROL	CONSTRAINTS				COMMENTS
		LAND	CONSTRUCTION	CLIMATE	OPERATION	
Disinfection						
Halogens	Low - Mod.	Low	None	Effectiveness varies with temperature	Chemical handling difficulties; over dosing can be harmful to receiving waters	Well demonstrated; chlorine as liquid or hypochlorites is most commonly used.
Radiation	High	Low	None	None	Requires thin film of wastewater; maintenance or complex equipment	Well documented in non-wastewater applications; frequently not economically competitive
Ozone	High	Low	None	None	Maintenance of sophisticated electrical and mechanical equipment; on-site generation reduces chemical handling problems	Needs demonstration, particularly for small flows
Land Disposal						
Land Application	Mod. - High	High	Sufficient depth to ground water and bedrock; high soil percolation rates; flat topography; holding lagoon outside of flood plain	Very sensitive to climate; may be limited to seasonal operation	Vegetation management; disinfection may be required	Well demonstrated
Infiltration	Low - Mod.	Mod.	Sufficient depth to bedrock and groundwater; high perk rates; outside of flood plain	May require special operation in winter	Disinfection may be required; alternating beds	Well demonstrated; low cost; low O&M
Soil Absorption (subsurface)	Low	Mod.	Same as above	Generally none for continental US	Minimal O&M	Well demonstrated; land above subsurface leach field may be used for recreation
Evaporation Ponds	Low	High	Sufficient depth to bedrock and groundwater; low soil permeability or lined	Very sensitive to climate	Odor and insect control	May use combination infiltration/evaporation
Surface Discharge	Low	Low	None	None	None	Demonstrated

TABLE A-7

SOLIDS STREAM TREATMENT OPTIONS

OPTION	IMPACT	REQUIREMENTS	WASTE STREAM GENERATED	COMMENTS
Dewatering				
Sand Drying Beds	Reduction in water content	High land requirements	Dry sludge and supernatant	Low cost but may require stabilized sludges, long drying periods, and cover .
Centrifugation		Energy costs	Dry sludge and supernatant	Significant O&M requirements; chemical conditioning required
Filtration (vacuum or pressure)		High energy, control, and chemical requirements	Dry sludge and supernatant	Generally not recommended for small communities because of process control requirements
Thickening	Increase solids content	Some energy required	Supernatant and thickened sludge	Often precedes dewatering
Stabilization				
Chemical Oxidation	Effective	Chemicals and power	Stabilized sludge or septage for dewatering	May constrain land application of the sludge; demonstrated
Chemical treatment	Effective	Chemicals and power	Stabilized sludge or septage for dewatering	Demonstrated
Lagoon	May be effective	Land	Stabilized sludge or septage for dewatering	Demonstrated; odor and insect problems
Aerobic or anaerobic digestion	Effective	Process control and equipment	Stabilized sludge or septage for dewatering	Demonstrated
Composting	Effective	Land and bulking material	Compost for marketing, distribution	Being demonstrated; dewatering required as a precursor; labor-intensive

TABLE A-8

DISPOSAL OF SOLIDS

OPTION	PROCESS CONTROLS REQUIRED	LAND AREA	CRITICAL FACTORS	ADVANTAGES
Landfill	Leachate, runoff and cover	low	Careful site evaluation required	Low cost; useful for most solids
Land Application	Application rate, runoff control, crop and groundwater monitoring	mod.	Toxics and nutrient loadings; pH., soil cation exchange capacity, permeability	Uses materials as resources
Market (e.g. compost)	Market must be well established; pricing, distribution and regulatory structure may be required	---	Same constraints as application to land	Potential revenue generat.; accomplishes resource recovery
Incineration	High energy and process control	mod.	Ash must be disposed of Air pollution requirements must be met	Not cost effective for small communities

APPENDIX B

COMMUNITY PROFILE SUMMARY, HILLTOWN

1.0 INTRODUCTION

The Hilltown Case Study area consists of three unincorporated water districts on the western slopes of a mountain range. Water Districts Number Two and Three are adjacent communities in a valley, while Number One is located in a neighboring watershed (Exhibit 1).*

1.1. GROWTH AND DEVELOPMENT

1.1.1 POPULATION AND ECONOMIC BASE

The results of a special 1978 census (Exhibit 2) indicate that the studied area is predominently seasonal, single family residences. While only 35% of the 3,010 housing units are permanently filled, the peak season occupancy of these residences is 7,609 persons. Adding transient visitors and summer students, the peak summer population could reach about 12,613, almost five times the permanent population of 2,648 (Exhibit 3).

Previous to the 1978 census, all population figures were estimated from U.S. Census data from a tract which contains several communities not included in the study area (Exhibits 4 to 12). It is not surprising that the results of the 1978 census varied slightly from these estimates. The actual 1978 permanent population is somewhat larger than the 1980 population predicted in the facilities plan. However, the methodology used to determine the estimated rate of growth is still valid and the projected saturation year-round population of 10,095 (Exhibit 13) may be reached somewhat earlier.

Both the facilities plan and the 1978 census show that the area's seasonal population seems to be growing faster than its permanent one. Water district Number Two has the largest percentage of permanent residents (40%) and undeveloped lots, while Number One has the smallest percentage of both. The overall permanent population density is about 2.55 persons per dwelling (Exhibit 13).

The economic base of the communities is quite sound. Despite the fact that over half of the residents are over fifty years old and about a quarter

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*In order to give a more concise narrative of the study area profile, all tables figures, and supporting documents were located in an appendix to the Community Profile. The exhibits have been omitted from this presentation. The objective is to illustrate a community profile summary, not to provide complete information about Hilltown. In this case, the supporting data presented in the various exhibits was quite lengthy.

of the principal wage earners are retired or unemployed, the average annual income is about $13,600 (Exhibits 14 to 18). The primary sources of employment are the various services provided for tourists and retired residents (Exhibit 19).

It is too early to assess the impact of the recently passed Proposition 13 on the ability of such communities to provide services such as those proposed in the 1978-1979 budget (Exhibits 20 to 22).

1.1.2 LAND USE

Existing development consists of a commercial core area, surrounded by one family mountain resort and general residential areas (Exhibits 23 to 28). Over 98% of all dwelling units are single family houses, with mobile homes accounting for about 60% of the remainder.

National forest, State park and other controlled developed areas lie beyond these developed areas (Exhibit 29). Undeveloped and forest areas comprise over 60% of the study area.

1.2 NATURAL AND PHYSICAL FEATURES

1.2.1 CLIMATE

Generally, the area is hot and dry in the summer and wet in the winter, with most of the average yearly precipitation of 24 inches occuring between November and April (Exhibits 30 to 32). Consequently, during the summer peak water loads, the rainfall is usually less than an inch per month and the streamflow lessens or ceases.

1.2.2 SOILS, TOPOGRAPHY, AND HAZARDS

The main problem with soils data for the study area is that the agencies with an interest in the subject either have not reviewed the area because it is remote, unincorporated and non-agricultural, or have only highly generalized information. Granite rocks which consist of undifferential granodibrite and tonalite underlie the entire study area (Exhibit 33). When weathered, these rocks form a decomposed granite (residium) which is found mainly on the gentler slopes (Exhibit 34). The soil text (Exhibits 35 to 36) summarizes the underlying area. Water District Number One, at an elevation of about 6,100 feet, has thin topsoils and deeper residium underneath with relatively good permeability. Water District Number Two is similar except for its portion adjacent to the Creek. This latter area is underlain by deep deposits of soil or extremely weathered permeable residium that should have excellent percolation. The Third Water District soils, from colluvial deposits, similarly have excellent permeability. As with the First District, the topsoils are thin. Together, these two districts reach elevations from 4,900 to 6,400 feet.

The flatter areas on the western portion of Water District Number One and the central eastern area of the Second District are underlain by ancient lake bed deposits. The topsoils covering these deposits should possess good permeability but a high water table frequently saturates the area.

Ancient lacustrine deposits were also found in Saunders Meadow. This area is underlain by porous organic silty sands for a depth of at least eight feet, and like the faults is underlain by a shallow water table. Similarly, the areas may have evolved from ancient landslides, producing a risk of reactivation from remotely generated earthquakes. A fault 3.5 miles away from the area has a recurrence interval of 100 years for producing seismic shaking of intensities ranging from XII to XIII in the portion of the service area nearest to the fault.

While there are no official records on storms or floods, from past heavy rain, water damage seemed most likely on low-lying parcels, especially on homes in the floodplain by the Creek.

1.2.3 SURFACE AND GROUND WATER

The surface water in the Districts has varying degrees of contamination, while the ground water is low in coliform bacteria (Exhibits 37 to 45). The Creek begins relatively unpolluted in Water District Number Three. This District's water supply comes from stream and spring diversions above the developed areas. When this supply is not sufficient, seven wells are available for use.

The Creek then continues into Water District Number Two through the several commercial districts, where it begins to show higher coliform bacteria levels. All areas, except for the north and west areas of Water District Number One, drain north to the Creek. After the Route 43 crossing and between a trailer park and the USC campus, the Creek becomes swampy for a while. Around this area, there are also animals nearby and tributaries from the flats and Water District Number One. Water District Number Two still relies on a stream diversion, as well as local wells, to obtain water. The First Water District, which is not located adjacent to the stream, relies solely on wells (Exhibits 46 to 48).

1.3 EXISTING WASTEWATER DISPOSAL PROFILE

1.3.1 WATER CONSUMPTION

The water consumption for the year 1975-1976 was over 18,000,000 cubic feet (Exhibit 49). The water requirements for Water District Number Two--the major users--has dropped almost 40% since 1975, probably from user conservation. As of 1976, the total well capacity for the three Districts was around 1,500 GPM and Creek diversion rights 571 GPM from January to July (Exhibit 50).

1.3.2 ON-SITE RESIDENTIAL WASTEWATER DISPOSAL

In Improvement District Number 2A (Exhibit 51), there were 332 connections to gravity sewers as of 1977. All other lots used on-site septic systems--including 150 housing units and numerous vacant lots in the Improvement District that chose not to be connected. In 1961, records of septic tanks and sub-surface disposal installations began to be recorded, and leach field and septic tank size controlled by Health Department Standards. The previous facilities report mentioned that some septic tanks installed before 1961 were pumped as often as every two months, since some of the earliest systems were nothing more than 55 gallon drums. About 887 septic tanks that are still in use were built before 1961. Many of these systems are old and need some cleaning and/or improving.

1.3.3 EXISTING PUBLIC SEWERAGE FACILITIES

The public gravity sewer completed in 1970 is available to all the residents in the Improvement District--even though some are still using septic tanks (Exhibit 52). Currently, this 0.2 mgd package sewage plant comprises a mixing zone, recreation zone, settling basin (clarifier), aerobic sludge digester and effluent chlorine contact zone (Exhibits 53 to 54).

There is space available to add a second unit to the plant, which is located on the western edge of the Second Water District. There has been no inflow/infiltration nor significant operational problems associated with the plant facilities (Exhibits 55 to 57).

Treated effluent from the facilities is transported under two miles to the effluent disposal ponds. These five ponds serve as evaporation/percolation ponds and as a storage pond, from which pumps draw water that is disposed of by surface irrigation in the adjacent hillsides. The buildup of biological solids at the bottom of the ponds limits the percolation. Currently, the loss of water is mainly due to irrigation and evaporation, not percolation.

1.4 EXISTING REGULATIONS AND INSTITUTIONS

1.4.1 REGULATORY CONSTRAINTS

There are discharge specifications for the existing treatment plant discharge to the evaporation/percolation ponds and water supply, as well as effluent and water supply monitoring guidelines (Exhibit 58). Similarly, the Wastewater Reclamation Criteria (Exhibit 59) presents the water quality level needed for wastewater used in various reclamation processes. In addition, sampling, reporting and reclamation plant regulations are given as well as the reliability requirements for uses permitting primary effluent.

The Septic Tank Ordinance (Exhibit 60) sets requirements for onsite wastewater systems, including specifications for location, capacity, size, site testing and installation.

The State Guidelines stipulating how surface water must be treated if used as a water supply (Exhibit 61) are based on raw water quality data and other source characteristics. Water Districts Numbers One and Three are defined as a Case I, while Number Two is a Case II under these guidelines. It is in the best interest of the community to prevent any degradation of their surface water supply sources which would result in reclassification and thus greatly increased water supply costs.

1.4.2 INSTITUTIONAL PROFILE

Currently, the water districts have set up one agency with the person in charge of the Facilities Report having responsibility for water quality.

APPENDIX C

GLOSSARY

201: Section 201 of P.L. 95-200, which details the construction grants program.

208: The area-wide wastewater management section of P.L. 92-500.

208 Agency: The planning agency responsible for completing and implementing area-wide water quality management plans.

40 CFR 35: The chapter of the Code of Federal Regulations concerned with the Construction Grants Program.

303e: River basic planning, required by Section 303e of P.L. 95-217.

701: Comprehensive community planning funded by the U.S. Department of Housing & Urban Development under Section 701 of the Housing & Community Development Act of 1956.

A-95: Mandatory intergovernmental review of Federal projects, established by the Office of Management and Budget Circular A-95.

The Act: The 1977 Clean Water Act (P.L.95-217) which amended the Federal Water Pollution Control Act of 1972 (P.L. 92-500).

Activated Sludge: A secondary treatment biological process used to remove various components of the influent wastewater. This is included as a conventional technology.

Alternative Technology: See section 2.2.2, page 13.

Ambient Water Quality: The existing stream or impoundment water quality.

Applicant: The local body authorized to apply for construction grants and which will operate and maintain the proposed facility. The Applicant can be a town, a county, a utility district, or a regional authority although it is referred to as the municipality in the Act and regulations.

Aquifer: a geological formation of permeable rock, sand or gravel that serves as a reservoir for groundwater.

Authorized Agent: The governmental subdivision which is authorized to represent the applicant in the construction grants process, for example a Sewer Board. In this manual the authorized agent is referred to as the Board.

Board: In this manual, the applicant's authorized agent.

Black Water: Wastewater generated from the toilet.

CAC: Citizen's Advisory Committee, one form of public involvement.

Circular Reasoning: See proof by assumption.

Clearinghouse: See A-95. Besides the regional and state clearinghouse reviews under A-95, this term may also mean the EPA Small Wastewater Flows Clearinghouse established to provide a disemination point for information and research related to technologies (see page 3).

COE: U.S. Army Corps of Engineers (Civil Projects)

Community: The group of persons within the service area who are in a position to influence how and where services are provided. This group could include, in addition to the officials of the Applicants Authorized Agent, other elected and appointed officials, interested citizens, and special interest groups. In the cases where a referendum or vote of town meeting is required, all eligible voters are included in this group.

Coventional Technology: Proven systems which are not alternative or innovative (see 2.2.2).

Cost-Effectiveness: A procedure specified by the Construction Grants Program to determine the most efficient alternative plan (Appendix A of 40 CFR 35 provides guidelines).

Design Life: The period for which equipment or an entire facility can be expected to perform adquately.

Design Period: The number of years for which the planned facility is expected to provide service, generally twenty years under the construction grants program.

Developable: See section 5.1.1, page 74.

Developed: See section 5.1.1, page 74.

Discounting: The process of analyzing future costs and revenues to consider the effects of interest and inflation, and make all dollar amounts comparable on an equivalent basis.

EDA: Economic Development Administration, U.S. Department of Commerce.

Effluent: partially or fully treated wastewater flowing out of a treatment facility.

EIS: Environmental Impact Statements as required by the National Environmental Policy Act.

Engineer: The registered engineer actually performing the work for the grantee. While the engineer could be a staff member of the grantee, in small communities a consultant is generally retained.

Evapotranspiration Systems: Systems which depend on evaporation and transpiration (loss of water from plants) for wastewater disposal.

FMHA: Farmers Home Administration, U.S. Department of Agriculture.

Generic Technologies: A term used in this manual to describe the group of technologies which use different methods to perform the same task.

Gravity Sewer: A collection system where gravity is used to transport wastewater from the homes to a centralized treatment or disposal facility. Periodically the wastewater may be pumped to a higher elevation, but energy costs are generally low since water flows downhill. Most gravity sewers are conventional technologies; small diameter gravity sewers transporting septic tank effluent qualify as alternative technology.

Greywater: All non-toilet household wastewater.

HUD: U.S. Department of Housing and Urban Development.

Hydraulic Overload: A condition when the quantity of wastewater flowing into a facility exceeds its design capacity.

I/I: Inflow and Infiltration; a term used in the Construction Grants regulations to identify water entering a wastewater collection system through damaged pipes or illegal connections.

Indirect Impact: Another term for secondary impacts.

Infiltration: Seepage of a liquid through the solid soil. It may also refer to the seepage of effluent into the ground to the aquifer or of ground water into cracked or broken sewers.

Influent: Wastewater as received at a treatment facility.

Land Application: A method for distributing partially or fully treated wastewater onto land where it receives further treatment by the soils and eventually reaches the ground water. Land application can either be subsurface (leaching fields) or surface (irrigation, landspreading with a truck, etc.). In some cases, land treatment may be used as a treatment step alone, with underdrains to collect the effluent for disposal elsewhere. Generally considered alternative or innovative.

Leaching Fields: The most commonly used on-site disposal technique consisting of tiles which distribute septic tank effluent for subsurface land application. This is a type of soil absorption system.

Lagoon/Stabilization Pond: An impoundment designed to enhance the natural purification of wastewater without major input of energy by allowing enough time and mixing for biologic activity.

Natural Resource Limitation Areas: Land which is particularly sensitive to development, such as steep hillsides, wetlands and floodplans. Also referred to as sensitive areas.

Non-Degradation: A water quality classification used to denote a water body to which no pollutants may be legally added.

NPDES: National Pollutant Discharge Elimination System which requires that all treatment plants discharging into surface waters obtain a permit from the U.S. Environmental Protection Agency specifying effluent quality.

O&M: Operation and maintenance of a wastewater facility.

On-Site System: A self-contained system which provides both treatment and disposal of wastewater on an individual lot.

On-Site Management District: A public entity authorized to operate and control public or privately-owned on-site systems.

Potable: Drinkable.

Pre-Application: The phase of the Grants Program where the Grantee--frequently with the assistance of a consulting engineer--prepares an application for Step 1 grant funds.

Present Worth: An estimate of the amount of money which would now equal all future costs of the wastewater system. It is the sum of all construction and O&M costs for the design period, discounted to the present.

Pressure Sewers: A collection system in which wastewater is pumped under pressure from homes into a pressurized main and conveyed to an existing collection system or directly to treatment/disposal. Grinder pump pressure sewer systems use individual grinder pumps to pump raw sewage from each home. STEP systems utilize simpler pump to convey septic tank effluent.

Priority List: An annual state ranking of projects, which is developed by consideration of the severity of current problems, and used to decide which projects receive funding.

Proof By Assumption: See circular reasoning.

Public Hearing: An open meeting held by the grant applicant to obtain formal comments on a plan. Notification of the public through newspaper and other media advertisements is required. A transcript of the hearing is maintained.

Public Meeting: An informal meeting frequently used as a means to develop public participation in a program. No legal record of the meeting is necessary.

Public Participation: A program required by the construction grants program to insure that citizens have been consulted and informed throughout the planning process.

Receiving Waters: Streams into which treated wastewater is discharged.

Reserve Capacity: Capacity included in facilities above that needed to serve current connections, accommodate future growth. Excessive levels of reserve capacity are not eligible for Construction Grants.

Residuals: The by-products of wastewater treatment processes. These include sewage sludge, septage, and waste liquid flows from dewatering operations as well as emissions to the air.

Reviewers: State and/or EPA staff responsible for administering the Grants Program in each state. This responsibility includes review of grant applications, facilities plans, and facilities designs, plus supervision of construction.

Rural States: States which are required by the construction grants program to set aside 4% of their allotment for funding of innovative and alternative technologies in rural areas. These states have a rural population of 25% or greater:

Alabama	Kentucky	New Hampshire	South Dakota
Alaska	Louisianna	New Mexico	Tennessee
Arkansas	Maine	North Carolina	Vermont
Delaware	Michigan	North Dakota	Virginia
Georgia	Minnesota	Oklahoma	Washington
Idaho	Missouri	Oregon	West Virginia
Indiana	Mississippi	Pennsylvania	Wisconsin
Iowa	Montana	South Carolina	Wyoming
Kansas	Nebraska		

Salvage Value: The anticipated value of any portion of a facility, including the land, at the end of the design period.

SCS: Soil Conservation Service, U.S. Department of Agriculture.

Secondary Impacts: Effects of a project arising through induced changes in population, economic growth and land use, and the environmental effects resulting from these changes.

Sensitive Areas: See Natural Resources Limitation Areas.

Septage: The solid and liquid material removed from a septic tank during pumping.

Service Area: The geographical area in which the Grantee is responsible for providing wastewater management services.

Sludge: The precipitated solid matter produced in the sewage treatment process. (2-5% solids, 95-98% water)

Soil Absorption System (SAS): A subsurface land application system for wastewater disposal (e.g., a leach field).

Spray Irrigation System: A method of land application in which effluent is sprayed over agricultural fields.

Step I: Facilities planning grants for the study of wastewater management options and the selection of the most cost-effective level and type of treatment.

Step II: Facilities grants for the design of the most cost-effective alternative as determined by the Step I process. During this phase plans and specifications for the new facilities and/or management program are developed.

Step III: Grants for the implementation of the plans designed in Step II. This generally includes the construction of facilities.

Surficial: Of or relating to the surface.

Time Staging: Scheduling construction of phases of a project over time to meet future demands for service.

Trickling Filters: A fixed film biological wastewater treatment process capable of producing an effluent of secondary standard quality; one of several conventional processes for treatment of wastewater.

Unconfined Aquifer: A ground water reservoir which is continually recharged by water seeping through the soil from the surface. Also known as a water table aquifer.

Undevelopable: See section 5.1.1, page 74.

Uniform Plumbing Code: A code of practice frequently adopted by state regulatory authorities as the basis of building codes.

U.S.F.S.: United States Forest Service, U.S. Department of Agriculture

U.S.G.S.: United States Geological Survey, U.S. Department of the Interior.

Water Table Aquifer: See unconfined aquifer.

Waste Load Allocations: The maximum amount of a given substance that a surface water body can receive. Discharges will be issued a permit for only a portion of the theoretically acceptable waste load, as set by the state in the 303e plan.

Wetlands: Low lying lands which frequently have standing water on them such as swamps, marshes, and meadows; see natural resource limitation areas.